Design Elements for a Successful CO_2 Trading Program

Dallas Burtraw
Resources for the Future
Burtraw@RFF.org

California Air Resources Board
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None of whom know how much their previous work appears in this presentation.

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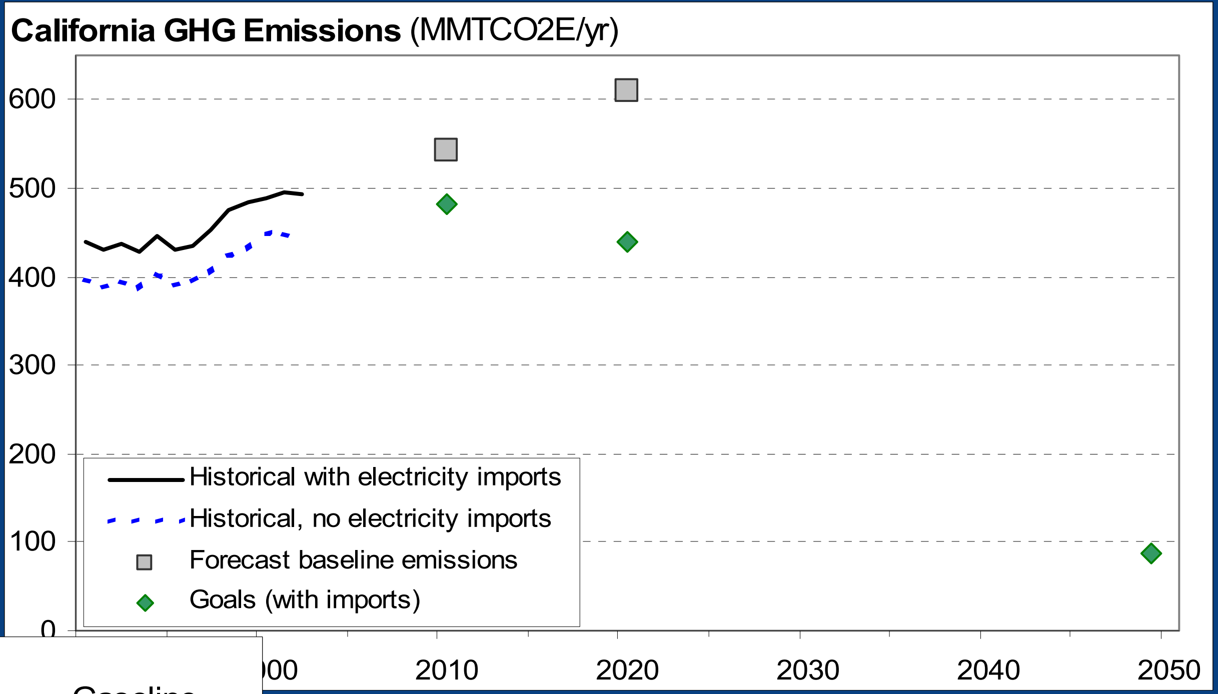
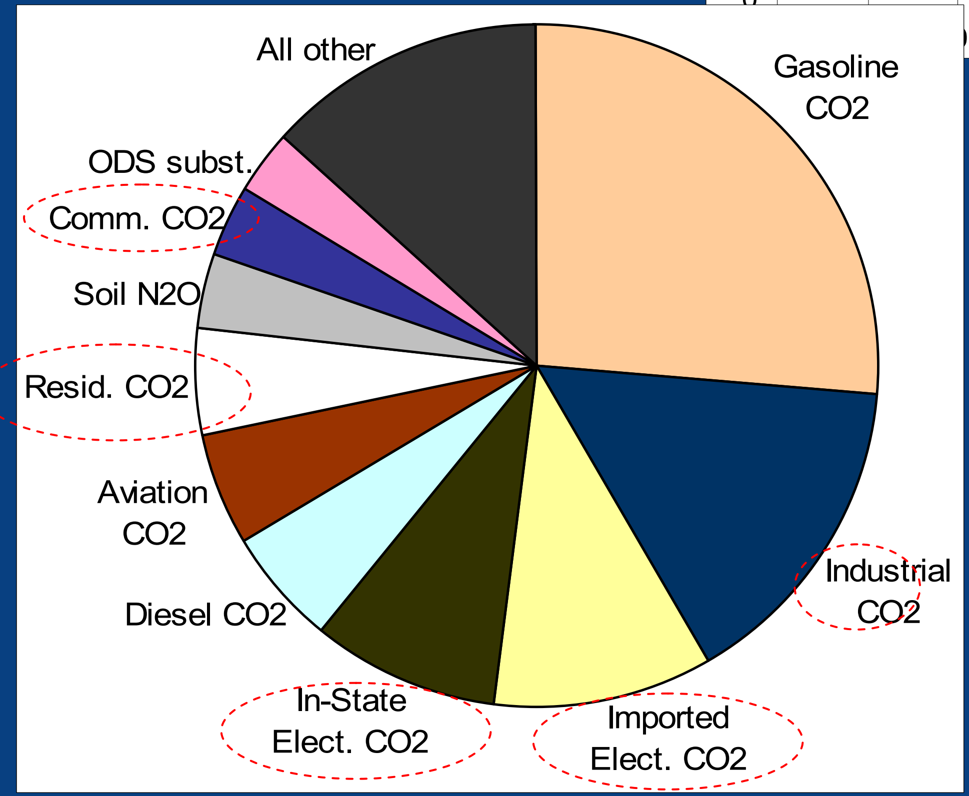
The Context in California





- Policy history
- Governor's goals
- Cap and Trade as part of policy portfolio

Data courtesy of Alex Farrell, UCBerkeley

Four Policy Initiatives for CO_2 Emission Trade

1) EU Emission Trading System
   - First phase 2005-2008
   - Trial phase tackling difficult issues in allocation, data management
   - Second phase commensurate with first Kyoto Compliance Period
2) Northeast Regional Greenhouse Gas Initiative (RGGI)
   - Modest target with binding cap and trade
   - Important innovation in design
   - Takes effect for 8-10 states in 2009
3) California
   - Extensive policy experience in energy efficiency, environment
   - Long-term goals
   - Moving toward cap and trade
4) Federal US Initiatives

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Roadmap for Presentation

Design Elements for a Successful CO_2 Trading Program

I. Background and basics – The SO_2 story
II. Price volatility, banking and safety valves
III. Innovation: prices complement policies
IV. Allocation – Why CO_2 is special
V. Program designs:
RGGI, EU, federal proposals
VI. Basic Architecture

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I. Background Perspective on Emission Trading – A New Experiment

- Cap & trade provides sources with flexibility to determine appropriate strategy
  - How to make reductions
  - Where to make reductions
  - When to make reductions
- For some problems, flexibility may not adequately address problem
  - Does it matter where reductions are made?
  - Does it matter when reductions are made?
- Cap & trade can work with source-specific controls or emission levies

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Prescriptive Regulation

- Reduced emissions significantly
- Very effective in many situations
  - Control or reduction options are limited or obvious
  - Control or reduction costs are reasonable
- Established *what* needed to be done
- Prescribed *how* and *when* each source was to do it

Bubbles, Offsets and Credits

- Assumed prescriptive regulatory infrastructure
- Provided some flexibility in how a source could comply, i.e. by getting reductions from another source
- Required government pre-approval to prevent:
  - "paper credits"
  - "anyway tons"

SO_2 Cap & Trade – A New Experiment

- Sets a maximum aggregate emission level
- Refocuses government's role
  - Emphasizes emission reduction and measurement
  - Enforces cap (holding sufficient allowances), avoids dictating how sources are to comply
  - Reduces administrative burden and cost while promoting greater environmental certainty

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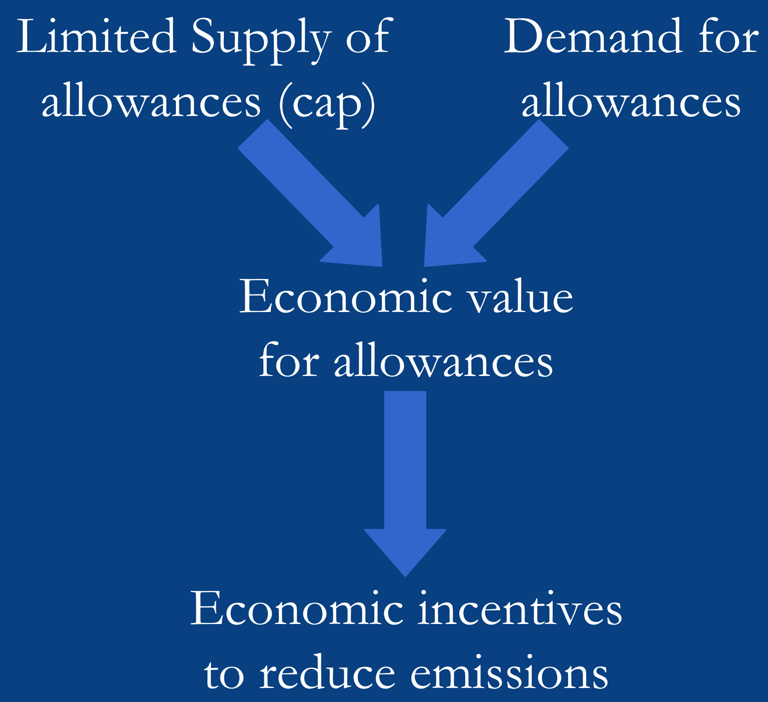
Why Cap & Trade Works

- Emission Cap
  - Limits emissions and maintains reductions
  - Provides market value and certainty
  - Allows trading without government approval
- Trading
  - Minimizes costs through compliance flexibility
  - Creates incentives to reduce costs going forward



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Keys to Successful Cap & Trade

- Setting the Emission Level (Cap)
  - To protects the environment, health
  - Technical and economic feasibility
  - Provides predictability to market participants
- Accountability
  - Accurate, complete emission <u>measurement</u>
  - Transparent emission and allowance <u>data</u>
  - Complete and consistent <u>enforcement</u> -- Predictable consequences for noncompliance
- Simplicity of design and operation
  - Minimal, but effective government role
  - Facilitates market and maximizes cost savings

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Infrastructure: Measurement

- Accurate, consistent measurement methods are essential
  - Ensure environmental integrity
- Government verification is important
  - Ensure environmental integrity
  - Encourage equity
  - Promote public acceptance

Infrastructure: Data Systems

- Emission and allowance data must be managed
  - Collect data from sources
  - QA/QC emission data
  - Maintain data
  - Disseminate information
- Computerized tracking systems provide benefits
  - Increase accuracy and consistency
  - Reduce time, effort and costs
  - Simplify data storage, maintenance, and retrieval
  - Improve access to relevant information

Infrastructure: Enforcement

- Resources for auditing emission measurements and equipment
- Resources for determining compliance
- Strong enforcement institutions
  - Political and institutional support
  - Authority to assess and collect penalties

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Public Perception of Trading

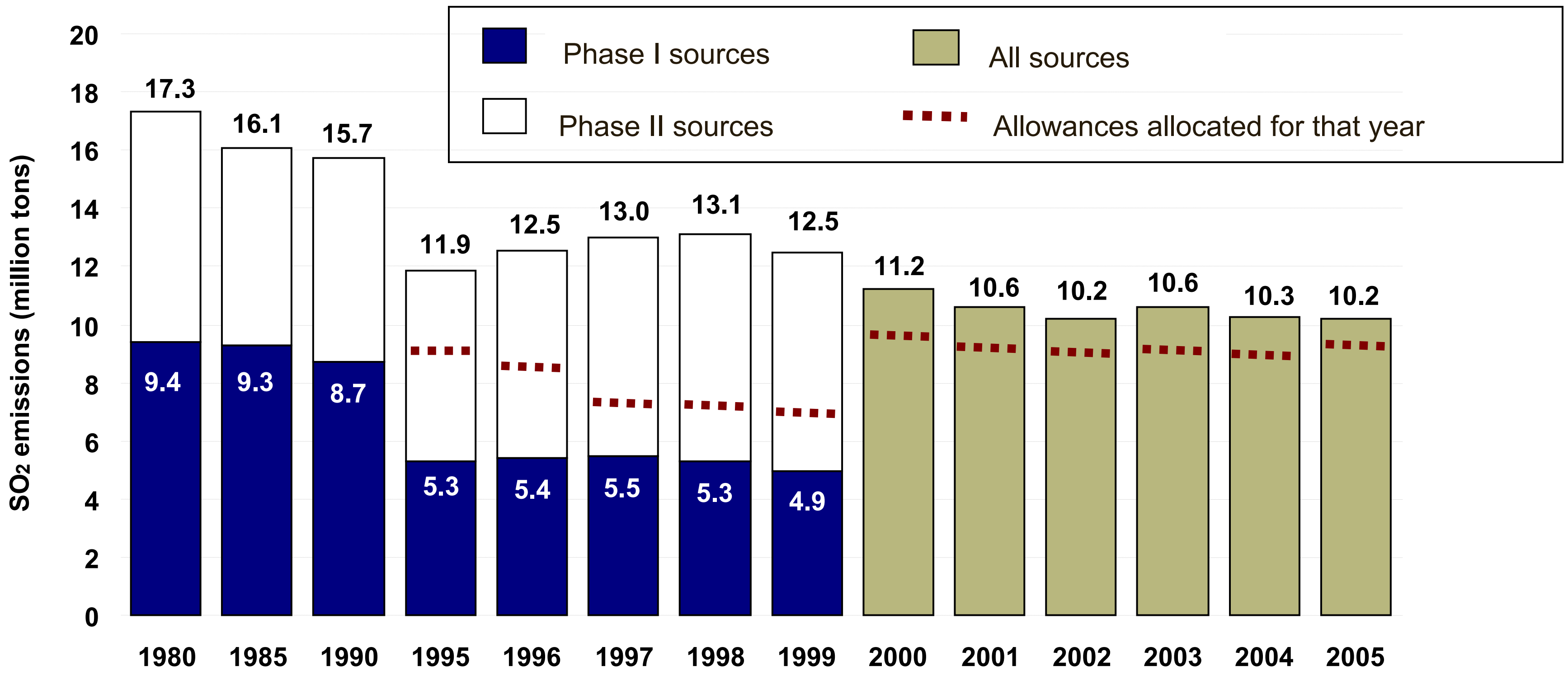
- Media reactions to first SO_2 allowance trades in 1992
  - "What's next, the L.A. Police Department trying to buy civil rights credits in Wisconsin?" (quote from A.P. wire story)
  - "Why applaud a deal that lets companies buy pollution rights? *People will die.*" (op. ed. in USA Today)

Reactions to Early Trades

Practical Perception of Trading

- Cap and trade lets firms *trade the right to pollute*, this is true.
- Cap and trade requires firms and consumers to *pay* for something that previously was given away for *free*.
- Prices complement policies, not replace them.
- Emission allowances have tremendous value.

SO_2 Emission Reductions Under the Acid Rain Program



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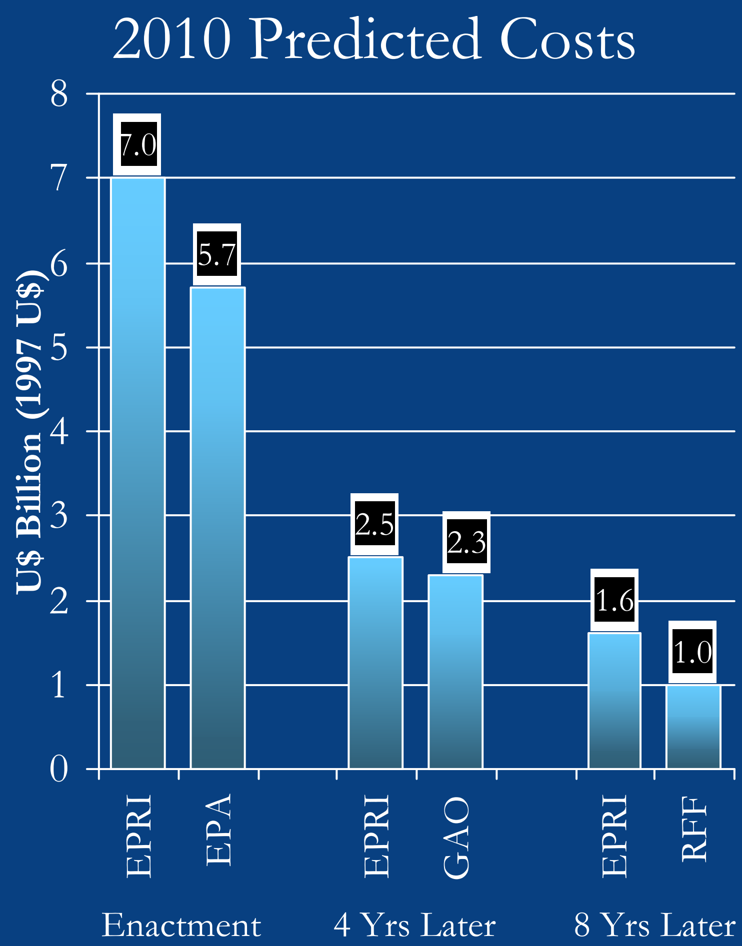
Annual SO_2 Compliance Costs are Low



Reasons for low cost

- Competition across emission reduction options
- Continuous incentive for innovation
- Banking provides timing flexibility
- Allowance price provides benchmark for decision making
- Trading not restricted

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Health Benefits of SO_2 Program are Significant

Health Benefits in 2010

- $50 billion in annual health benefits
- 10,000 premature deaths avoided

A Critical Perspective

- With benefits 30-50 times greater than costs, what aspect of cap-and-trade prevented further economically valuable emission reductions?

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Spatial Effects of Trading?

- In 1993, the NY AG sued EPA to restrict allowance sales.
- NY Assembly, later Senate, voted to constrain trades.
- 1998 agreement with Long Island Lighting Company (LILCO).
- 1998 Senator D'Amato likened long-range transport of acid rain to "airborne terrorism."

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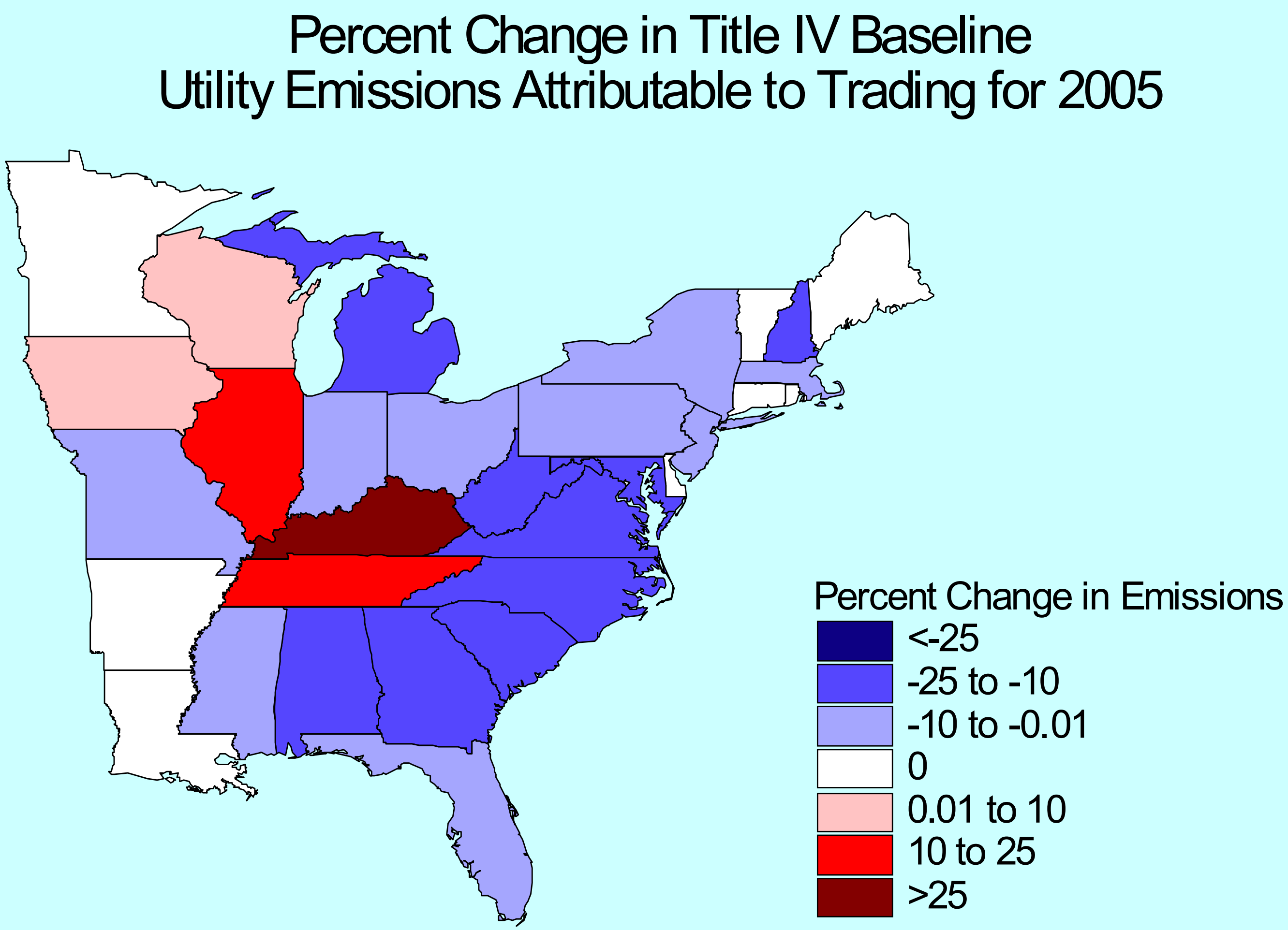
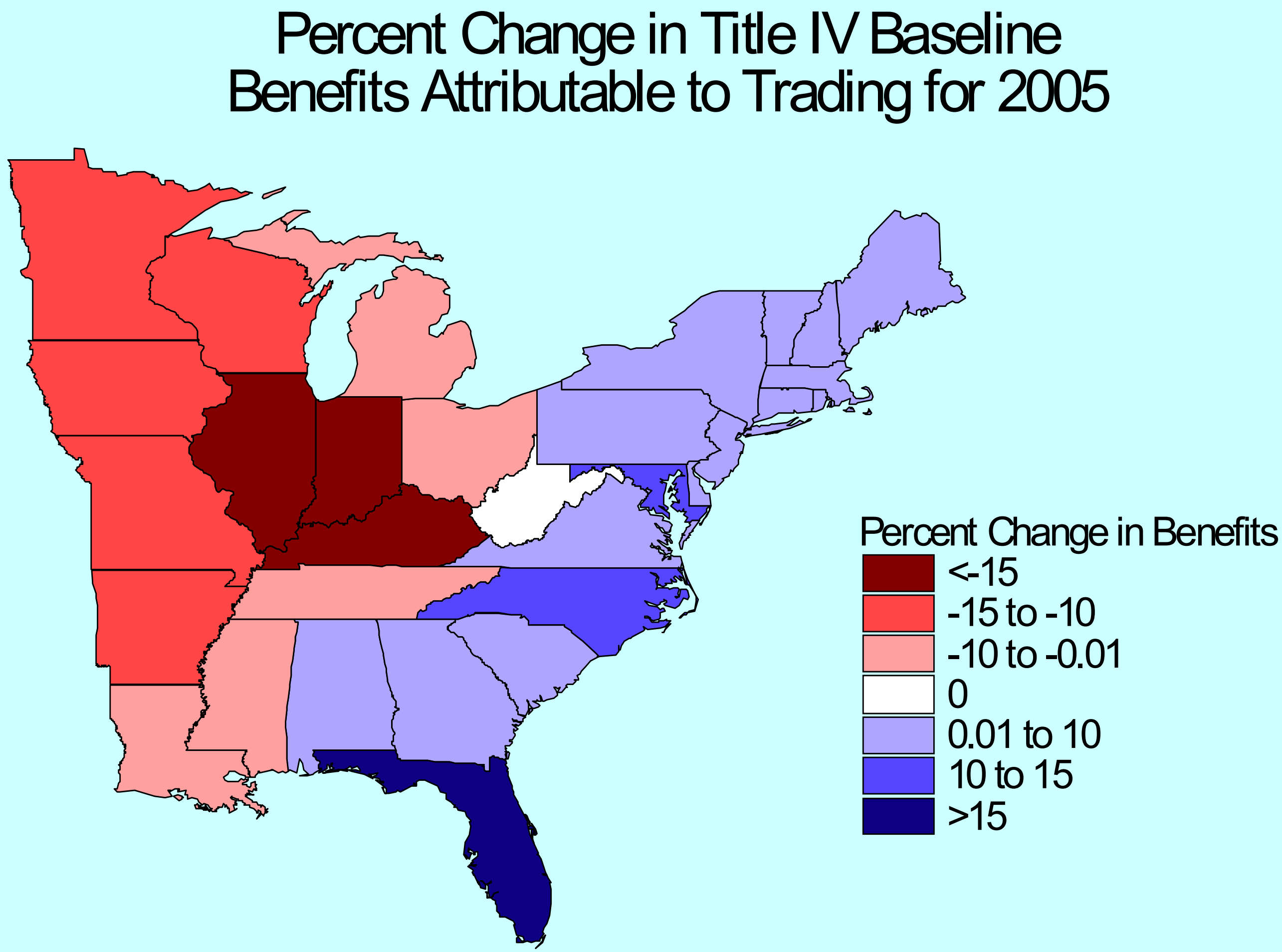
Effect of Trading on Emissions



"Regional Analysis of SO2 Allowance Trading" (*EST,* 99)

Effect of Trading on Health



"Regional Analysis of SO2 Allowance Trading" (*EST,* 99)

Lessons from SO_2 for GHG

- General lessons:
  - Emissions trading can be effective.
  - May be even more appropriate for GHGs because no "hotspots"
- Specific elements:
  - Banking
  - Transparency, monitoring and verification
  - Political, economic importance of allowance distribution

What might be different in a GHG system?

- Scope and point of regulation
- Higher stakes for distribution of allowances: auction vs. free allocation
- Mechanisms to limit price uncertainty (symmetric safety valve)
- Multiple gases and sequestration
- Program design to anticipate the international dimension

II. Price Volatility, Banking and Safety Valves

- Almost all emission markets have been successful, but…
- Poor attention to design can ruin anything (a building, a party, an electricity market, or an allowance market)
- One type of key problem -- price volatility
  - Previous programs lack flexibility mechanisms (banking, offsets, or safety valves), some for good reasons (e.g. episodic environmental problem)

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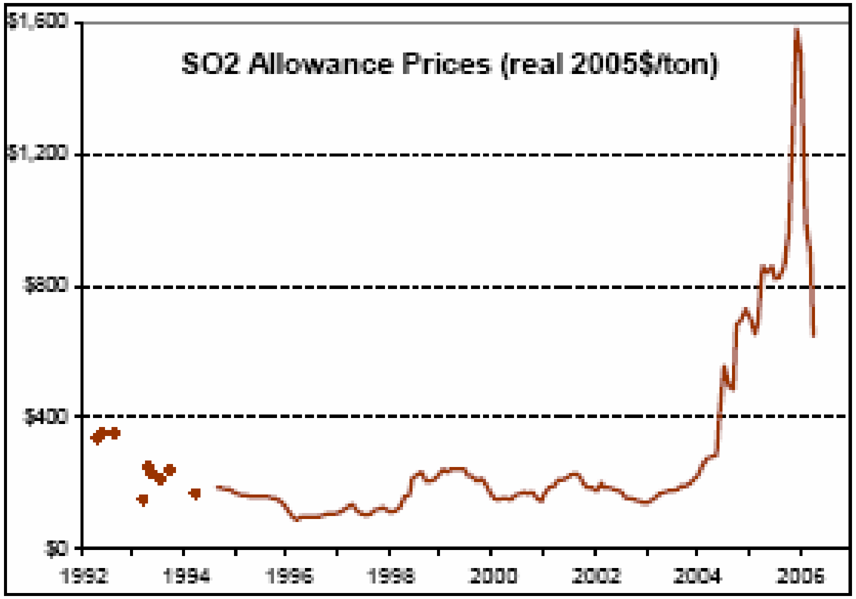
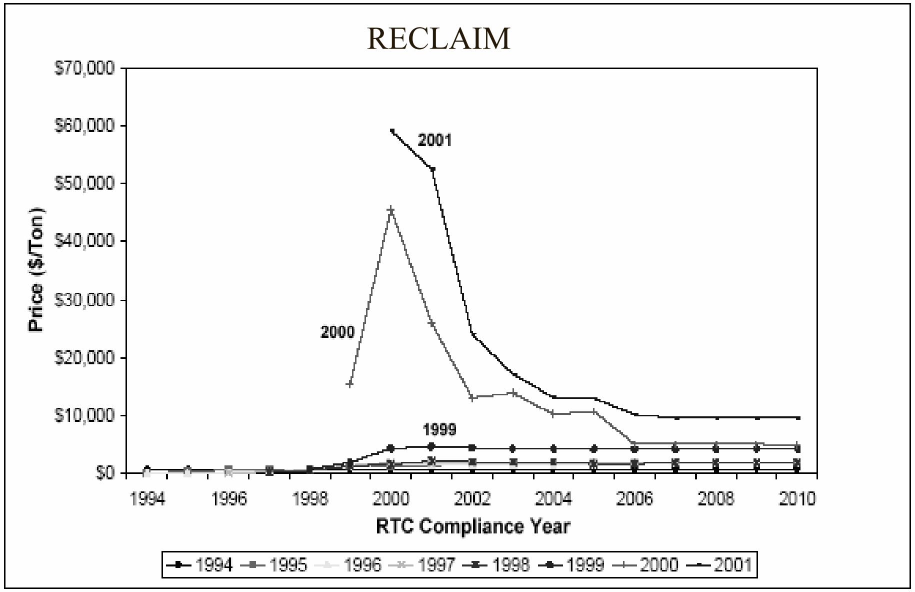
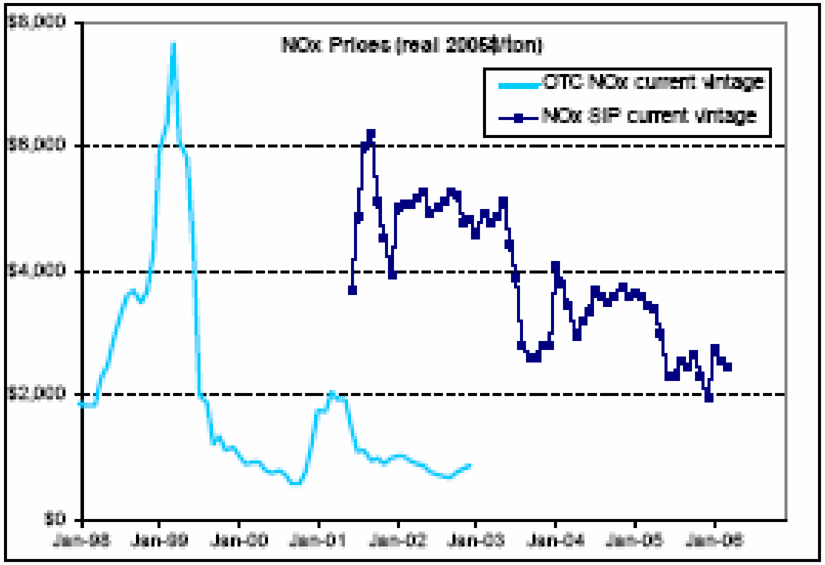
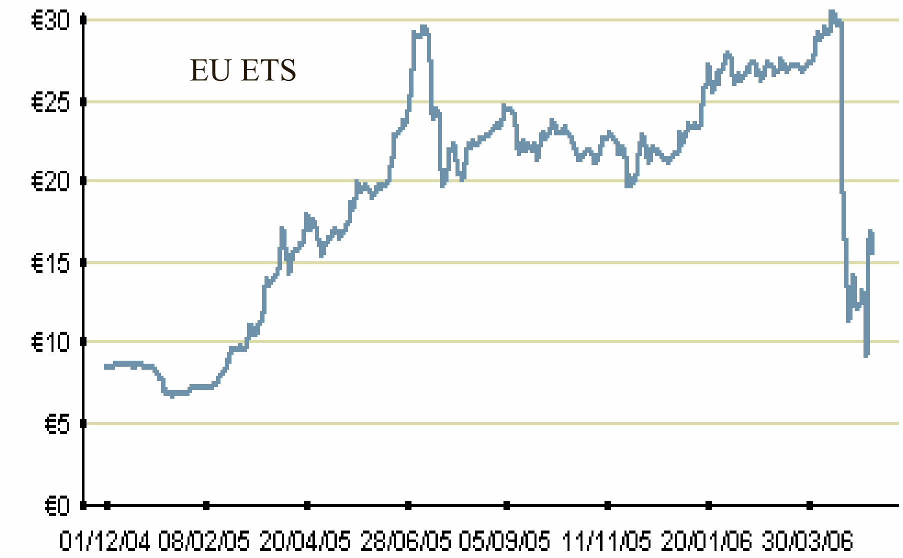
Volatility in Emission Markets





Source: South Coast Air Quality Management District (2002a).





Mechanisms for Inter-temporal Flexibility

Examples

- Safety Valves, Circuit Breakers, Intensity Targets
- Banking and Offsets

Advantages

- Price stability
- May increase efficiency

Disadvantages

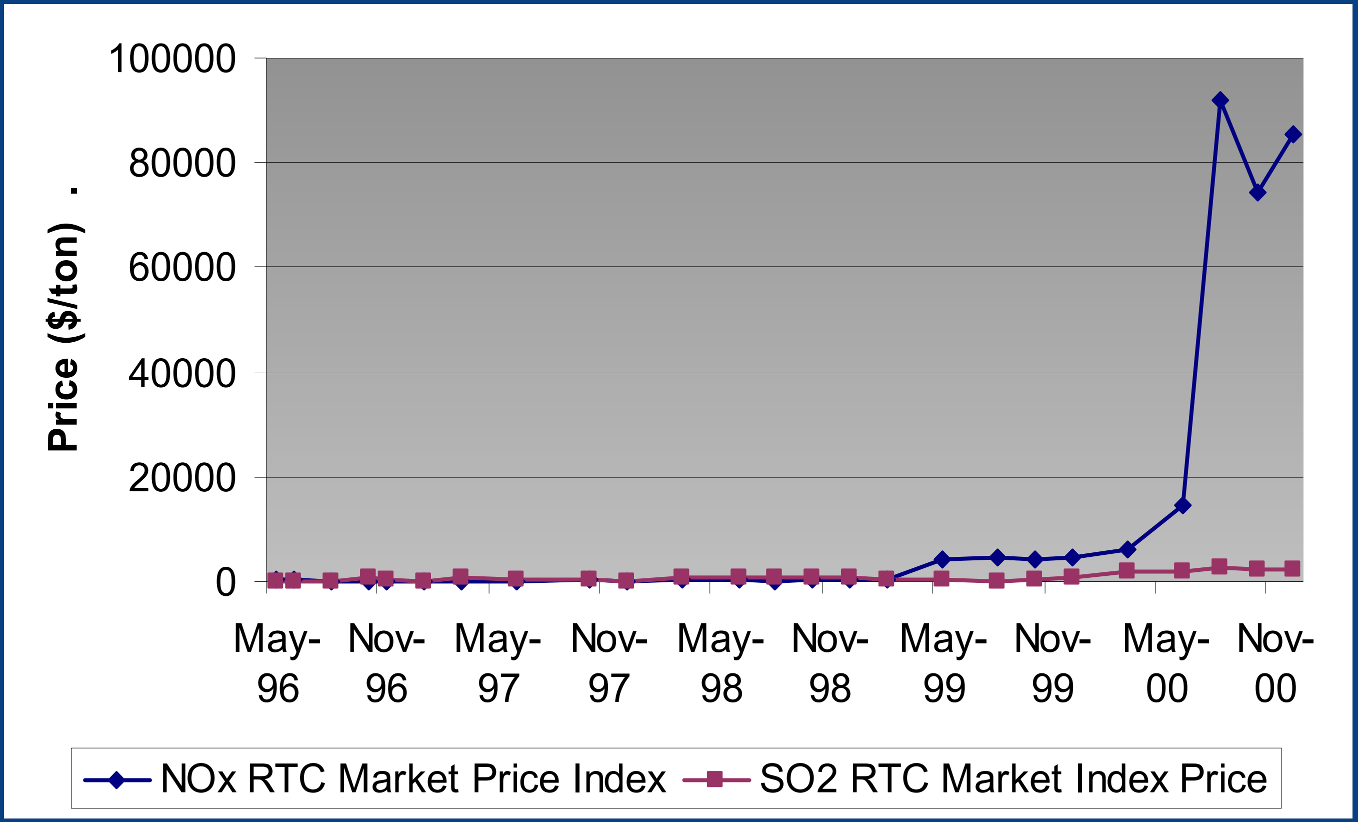
- Cannot mandate any particular technology or performance
- May reduce symbolic value
- Unintended consequences

The RECLAIM Experience

- The RECLAIM program is a cap-and trade program that began in 1994 and was expected to be fully implemented in 2003:
  - NOx emissions were to be reduced from 105 to 27 tons/day
  - SOx emissions were to be reduced from 26 to 10.5 tons/day
- Caps all facilities emitting 4 tons or more/year of NOx and/or SOx:
  - Initially affected 364 facilities
    - Included electric utilities, refineries and "other" emitters (cement kilns, diesel engines, process heaters, dryers, etc…,)
  - Excluded certain essential public services.

Market Reaction

SO_2 and NOx RTC (Compliance Year) Market Price Index



Source: Cantor Fitzgerald, EBS

- **NOx Trading continued throughout 2000 despite high prices**

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Reaction to the Price Increase

- In response, RECLAIM officials proposed to isolate utilities >50MWe from the NOx market.
  - Instead, utilities would pay into an “air quality investment program” $7.50/lb of NOx emitted beyond their initial allocation.
- In compliance with abatement orders, 37 air pollution control projects are underway and 29 more are planned
  - 17 utility boilers are in the process of installing SCR
- Effectively removed utilities from the market

Why did NOx RTC prices increase?

- Demand increased faster than expected.
- Low hydro year, low investment in electricity generation statewide in preceding years.
- Sources had not made early capital investments – no incentive for early reductions.
  - Low RTC prices before 2000, on average < $2000/ton;
  - A limited economic incentive to reduce emissions below the required level,
  - Absence of banking in the trading program

=> <u>No banking</u> resulted in <u>just-in-time</u> emission reductions!

Banking

- In SO_2 program the value of banked allowances vested industry in the program's success
- Banking encourages sources to reduce their emissions sooner and below required levels,
  - Allows sources to make extra reductions where and when it is cost-effective to do so;
  - Ensures that all reductions will have an economic value in the long-term even if the short term gain is small.
- Each banked ton represents a future ton of emissions
  - Tradeoff between the short and the long term;
  - RECLAIM decided the risk of variability in emissions due to the withdrawal of banked emissions was too great to allow banking.

Safety Valve Policies

- Fixed targets (quantities or prices) cannot respond to new information.
- An inherent attribute of market based policy is instantaneous feedback on marginal cost (allowance price).
- **Safety valve** instruments embody ***decision rules*** to respond to market information about costs.

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Economic Impact of Price Volatility Based on Experience To Date

- Unexpected price rise – **RECLAIM**.
- Unexpected price fall has been much more important in economic terms - **SO_2**
  - As noted, benefits of the Title IV SO_2 program appear to be 30-50 greater than costs.
  - Imagine safety valve 33% below mean of EPA (1990) cost forecasts.
  - In 2010 (absent CAIR) emission reductions of over 2 million tons (Banzhaf et al.).
  - Even using Congressional WTP in 1990 as an estimate of anticipated benefits, health benefits would still be $1.5-$1.95 billion per year!

Why the Symmetric Safety Valve is Important

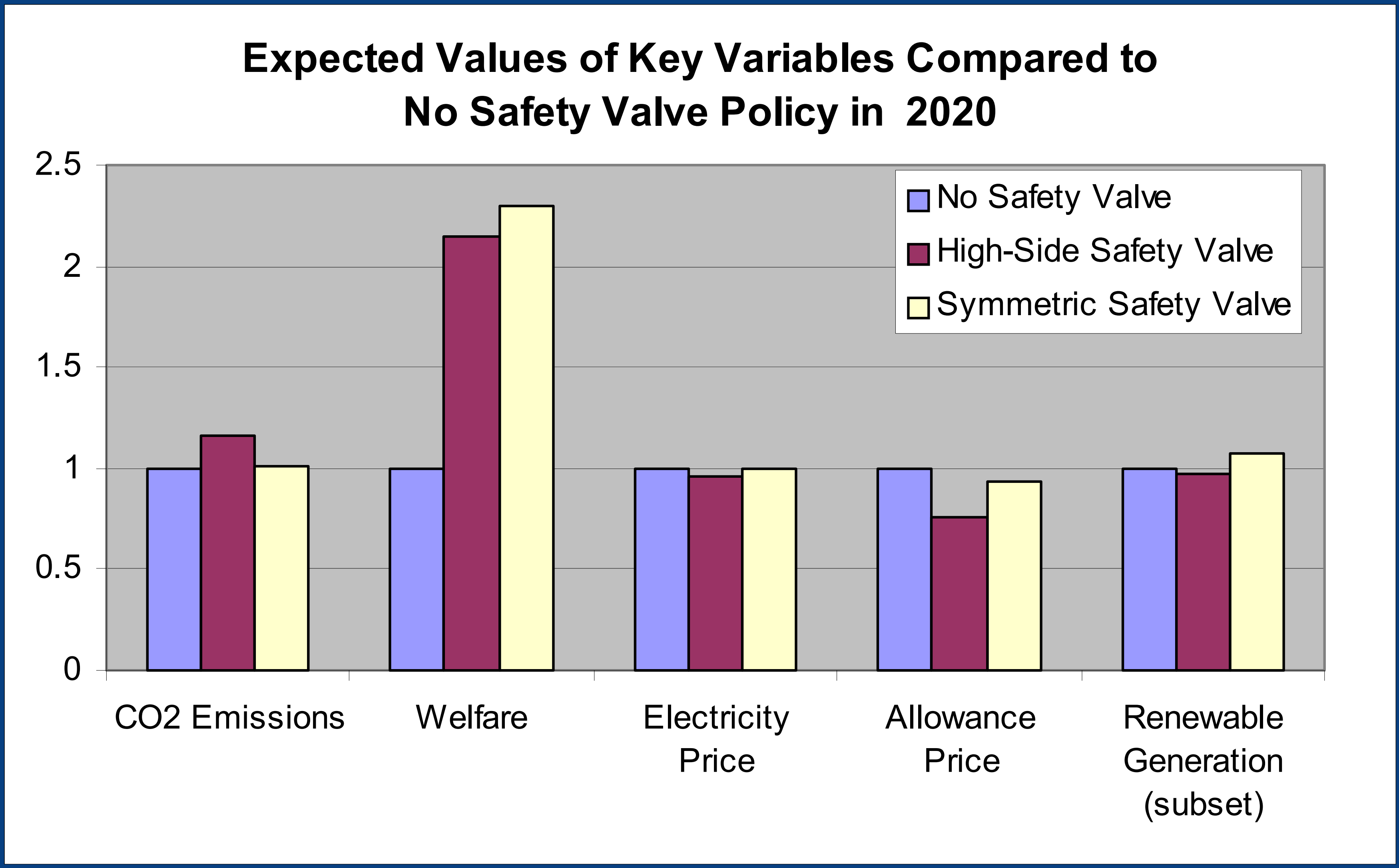
A one-sided safety valve has unintended consequences

- One-sided safety valve reduces risk of unexpected impacts on the economy. But…
- It breaks the emission cap
- Reduces incentive for innovation.
  - If the allowance price is capped then the upside profit potential for investors in clean technology is lower than in the uncapped case.
  - Thus, the one-sided safety valve lowers the investor's expected future profits and thereby limits incentives to invest in clean technologies.

A symmetric safety valve

- Adding a floor on allowance prices offsets these unintended consequences and improve welfare, efficiency.
- The most important example of unexpected prices to date: Imposing a floor on SO_2 allowance prices under Title IV would have improved economic welfare by \$1.5 billion to \$8.25 billion in a single year.

Taylor Series Approximations of Equilibrium Measures



III. Innovation: Prices Complement Policies

Allowance value inflates the energy costs for firms and the energy prices seen by consumers. When is this important? Valuable?

In the short run…

- For electricity firms, capital is fixed, but electricity firms have operational alternatives
- Prices promote diffusion of mature technology, the incentive to search for and capture of "low hanging fruit."
- But for consumers, in the short run prices can do little to affect behavior.
- Prices penalize those least able to pay

- In the long run prices coordinate decisions in the economy, giving signals to energy users. In the long run capital has time to adjust; prices provide incentives broadly.

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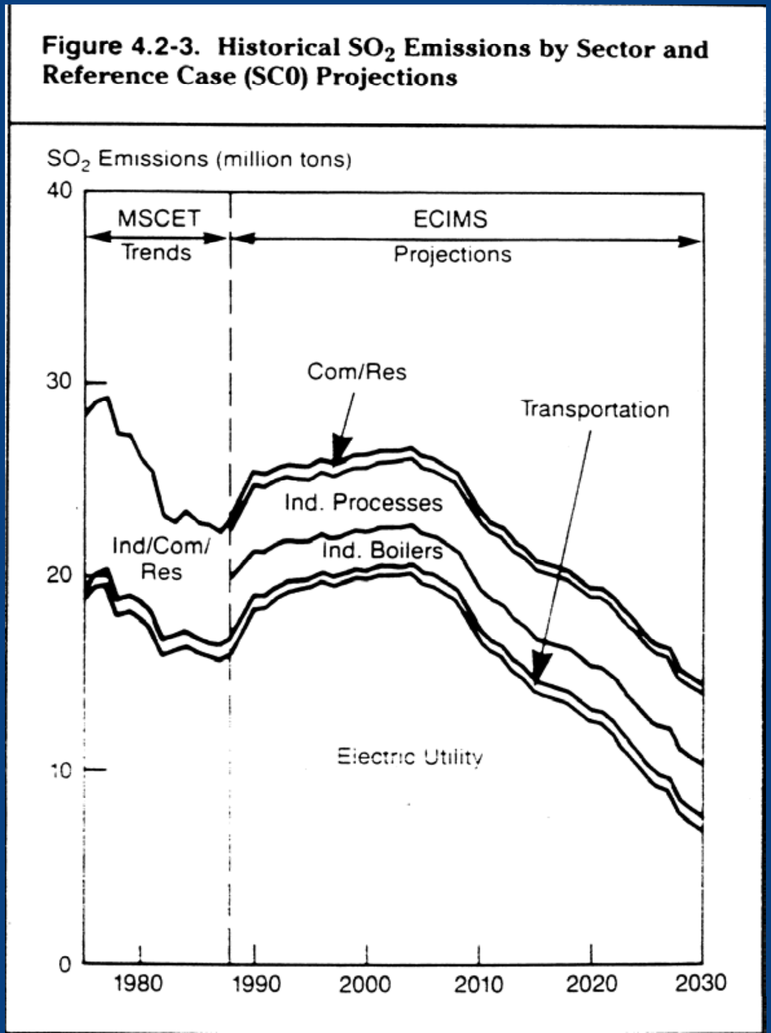
Waiting for the Big Technological Fix?
The storty of integrated gas combined cycle (IGCC)

NAPAP, 1980s. Reference case for electricity generation technology predicted precipitous drop in SO_2 **in 2005!** due to large-scale entry of **IGCC** (73GW by 2010).



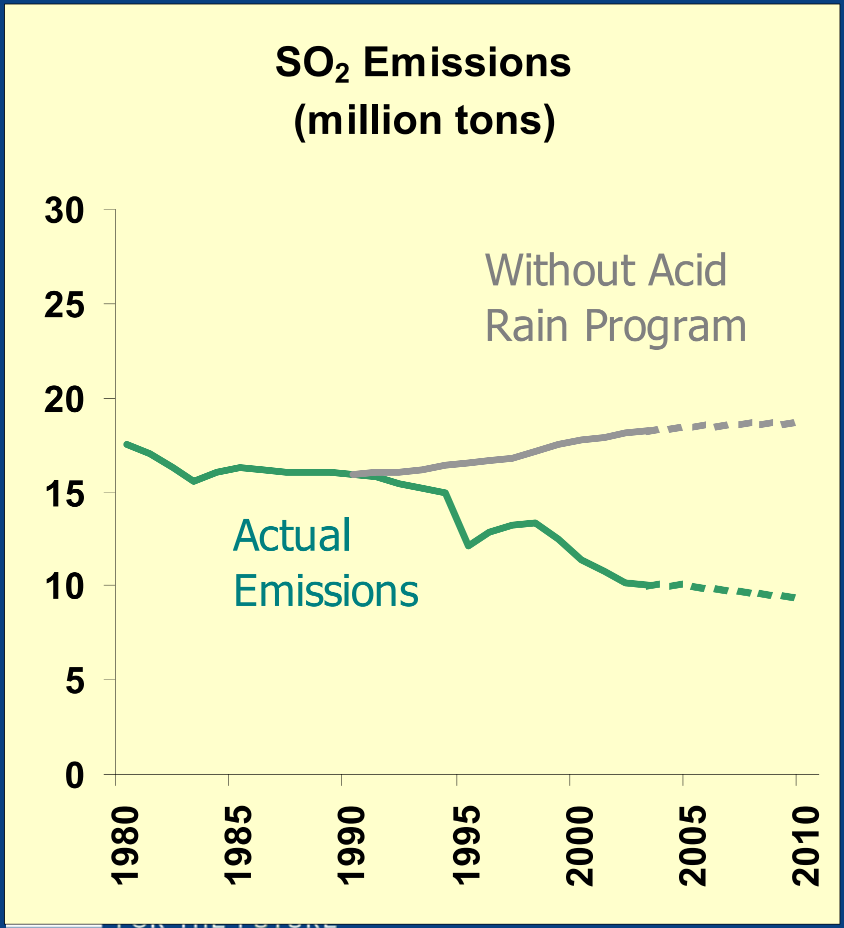
This case was basis of the view that policy intervention (cap and trade) was unnecessary.

Congress decided otherwise in 1990.
So what happened?

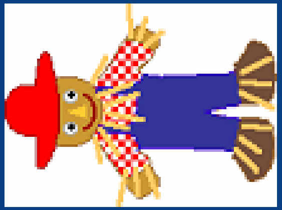
National Acid Precipitation Assessment Program, *1990 Integrated Assessment*

In the SO_2 Program, Modest Allowance Prices Provided Incentives that Affected Behavior

SO_2 emissions fell *much* faster than in the reference case, but without the big fix.



Innovations occurred through multiple small discoveries.



IGCC today?

…Still just one generation away.

Incremental Innovation Marked the Acid Rain Experience

Finding Cost Savings Away from the Lamp Post

- Fuel switching: low sulfur transportation costs ↓↓, investment ↑↑, diffusion of new technology
- Fuel blending: from 5 % (expectation) ↑ to 30-40% (achieved)
- Scrubbers: capital cost ↓, module redundancy ↓, removal rates↑
- Reform: organizational, regulatory

➢ Every option used technical capability currently available. Cap and trade forced competition among these options and provided incentives to innovate.

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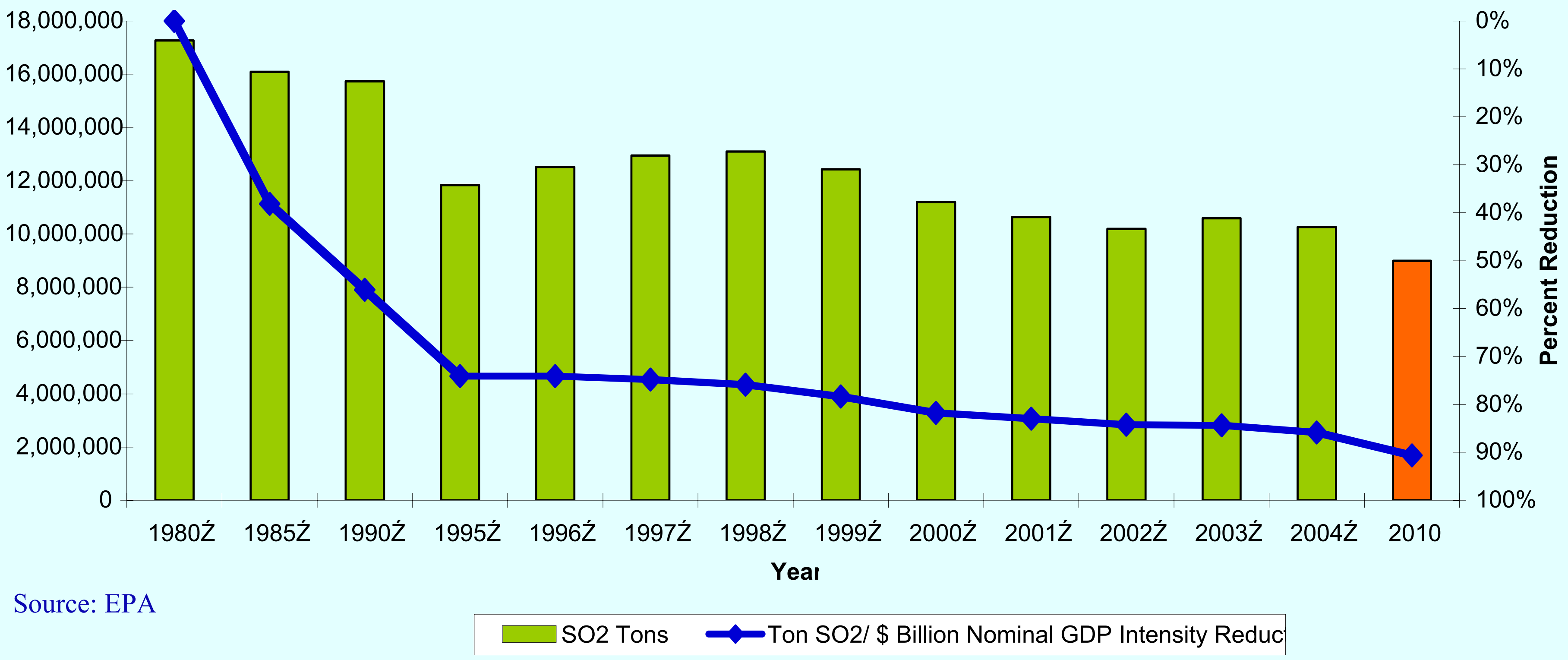
Evolutionary Progress

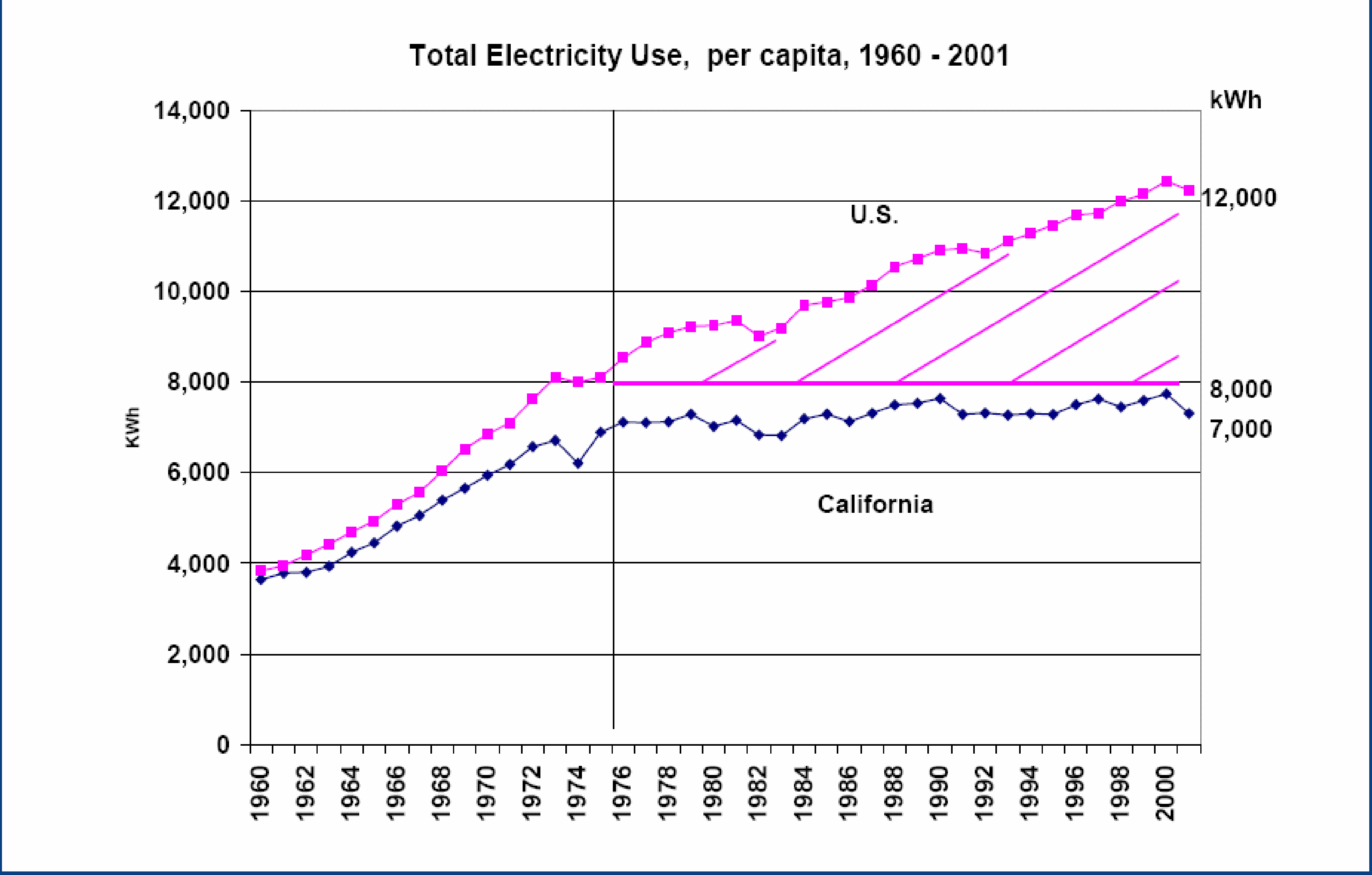
SO_2 Emissions v. SO_2 Emissions/GDP Intensity

Marginal Cost: ↓ 50-75% below forecasts
Total Cost: ↓ 30-40% below forecasts

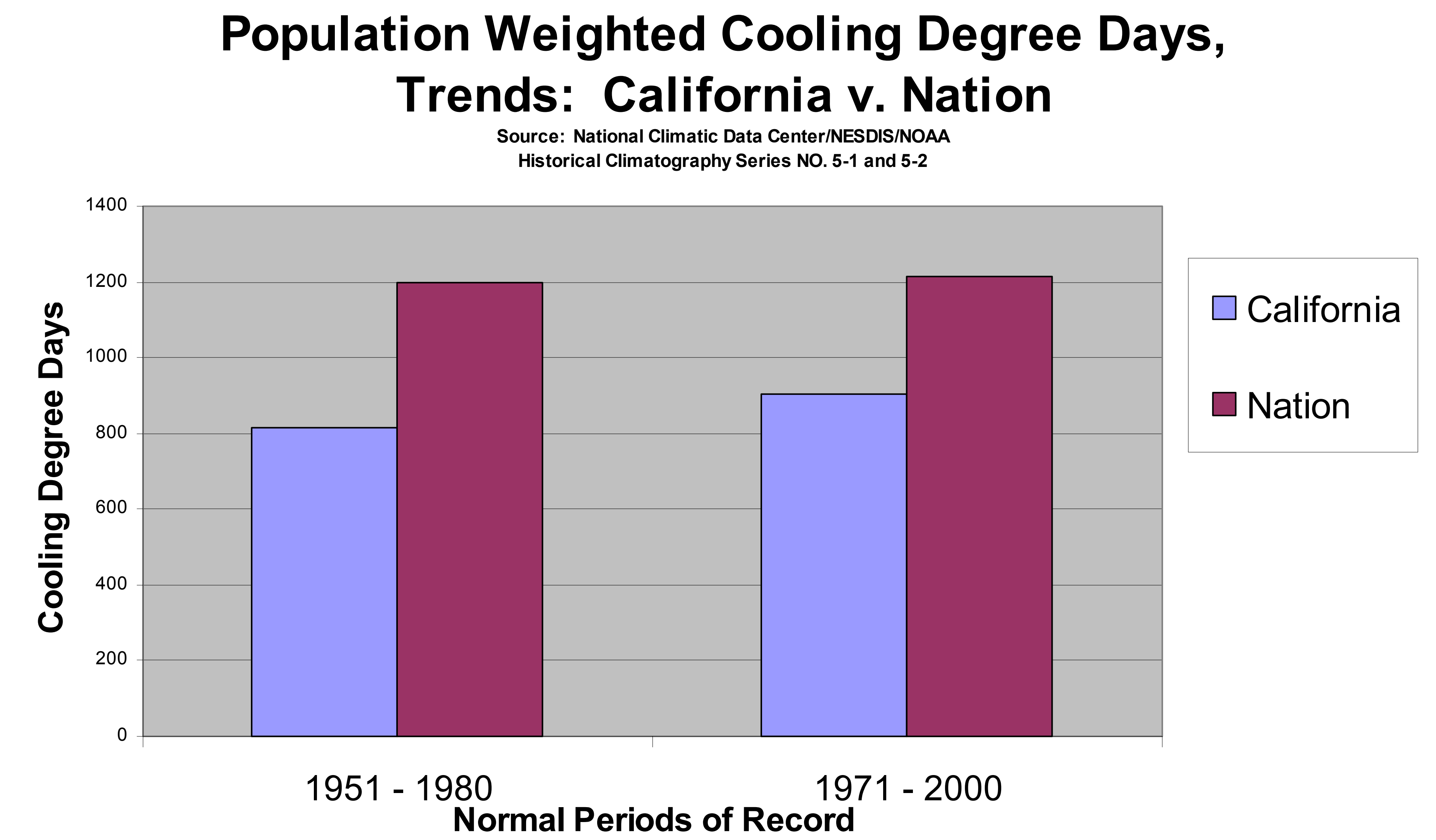


Source: EPA

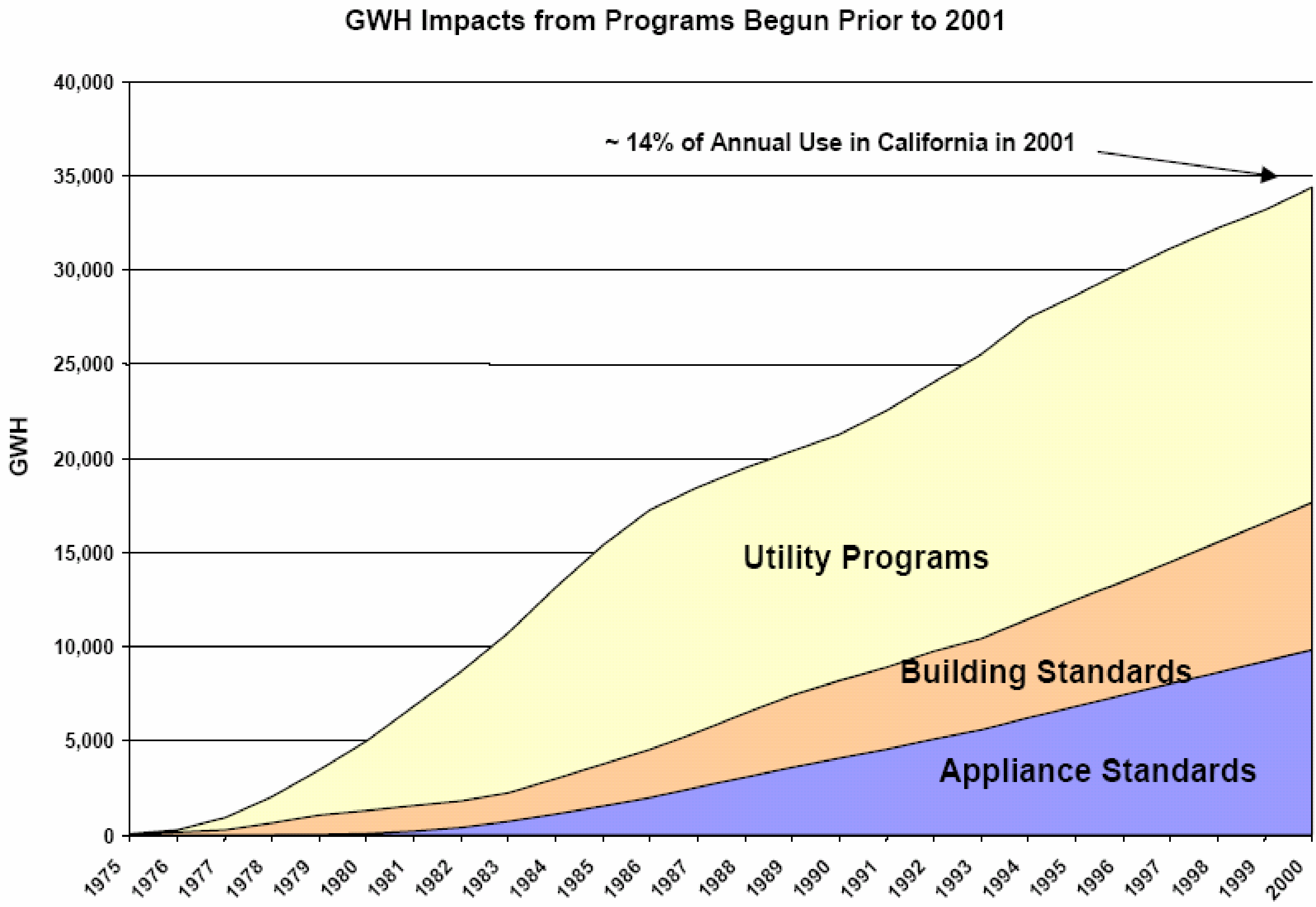
Evidence of Incremental Progress for CO_2: The Slow, Stop Regime in California



Controlling for Migration

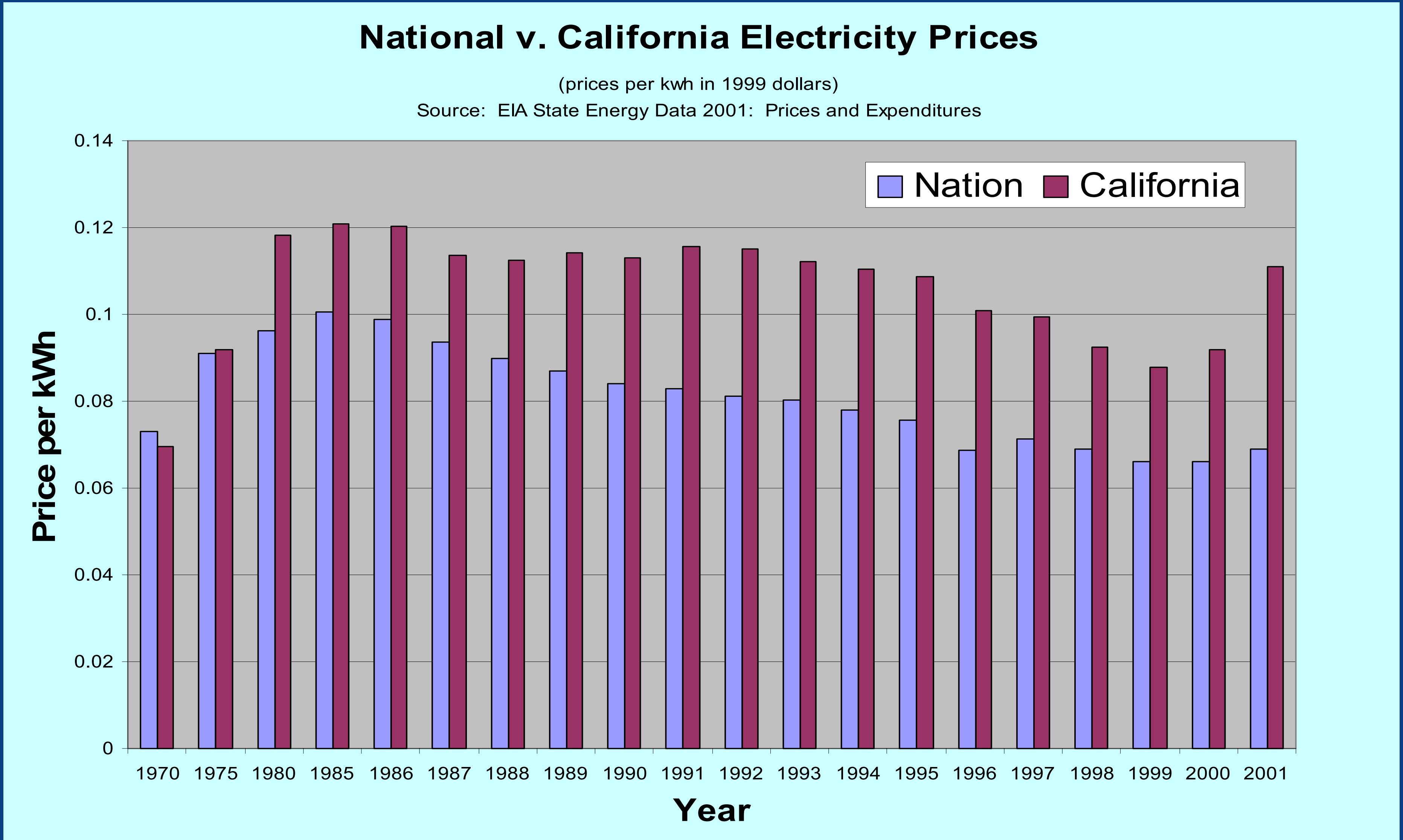


California Policy - Incremental, Cumulative



Source: Mike Messenger, CEC Staff, April 2003

Prices Also Contribute to Energy Savings



Prices Promote Incremental Progress: The Lesson for Climate Change

"If only because radical innovations are uncommon and unpredictable, **incremental innovations are the most appropriate policy targets**.…Despite their portrayal in the press and elsewhere as critical events, 'radical' breakthroughs in scientific or technological knowledge generally are less economically significant than the lengthy series of incremental innovations and improvements necessary to arrive at a cost-effective product that is attractive to users.…An appreciation of incremental advances is essential to the formulation of policies for fostering innovation."

- Alic, Mowery and Rubin, *U.S. Technology and Innovation Policies,* Pew Center 2003.

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Possible Strategy for California:
Expand the role of prices over time

- Phase in sectors affected by cap and trade
  - Provides time for, and incentives to adjust capital.
  - Emission reductions are found under the light post….Expanding role of prices through the economy over time illuminates an expanding set of opportunities.
- Allow, encourage significant initial banking and add symmetric safety valve
  - Encourages early technology adoption, early emission reductions.
  - Encourages research and investment
  - Creates "buy in" on the part of regulated firms.
  - Lowers cost, guards against program disruptions.
- Phase in an auction
  - Increase revenues over time going to public purposes.
    - Research and investment.
    - Tax reductions for business, consumers.

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IV. Allocation

Annual Asset Value of Emission Allowances

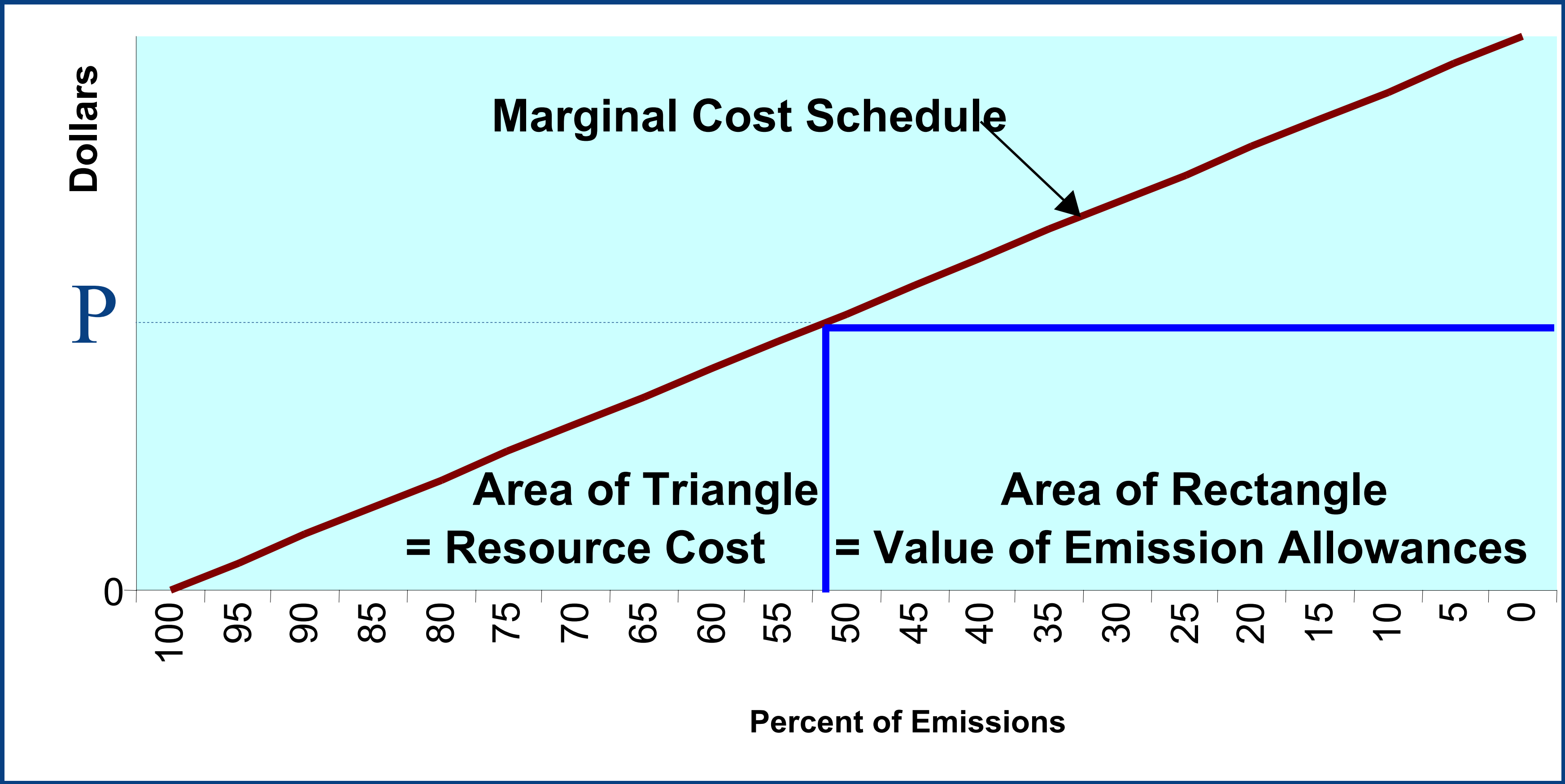
NOx
$1.7 Billion

SO2
$2.7 Billion

Carbon 34%
Reduction (Kyoto)
Economy Wide
$450 Billion

Carbon 6%
Reduction
in Electricity
$15-$24 Billion

The Previous SO_2 Trading Program Aimed at 50% Reductions



→ Value of permits = 2 times the cost of emission reductions

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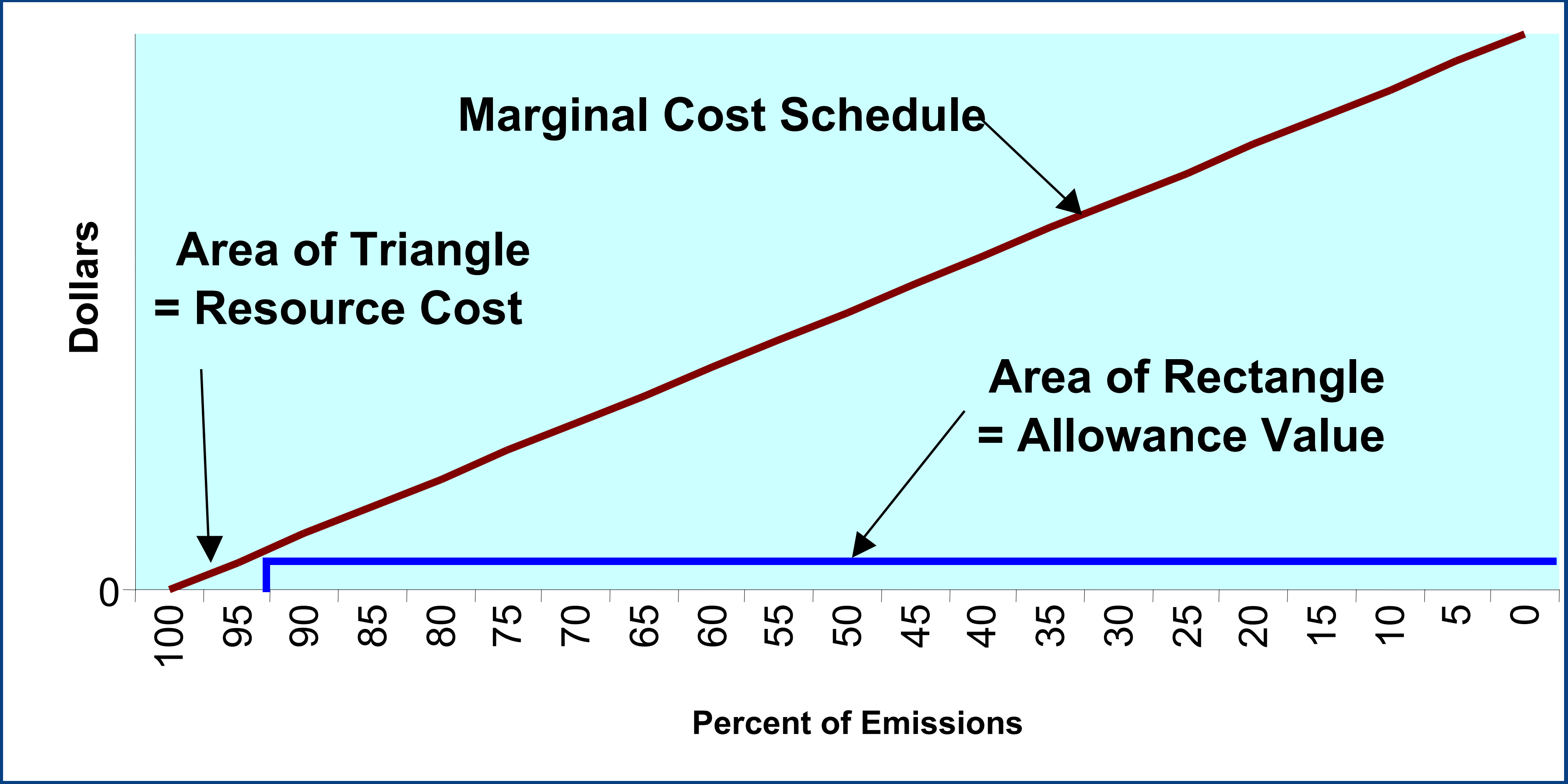
Why Carbon is Special…



→ Value of Permits = 20 times Total Cost

A Key Issue: The Determination of Price in the Electricity Market

- Variable Cost Ordering ($/MWh):
  fuel + VOM + allowances
- Total Cost ($):
  capital + FOM + fuel + VOM + allowances - allocation
- Price ($/MWh):

  Regulated Price = Average Cost = (Total Cost ÷ Production)

  => Price [Auction] > Price [Free]

Variable cost does not depend on allocation but electricity price does.

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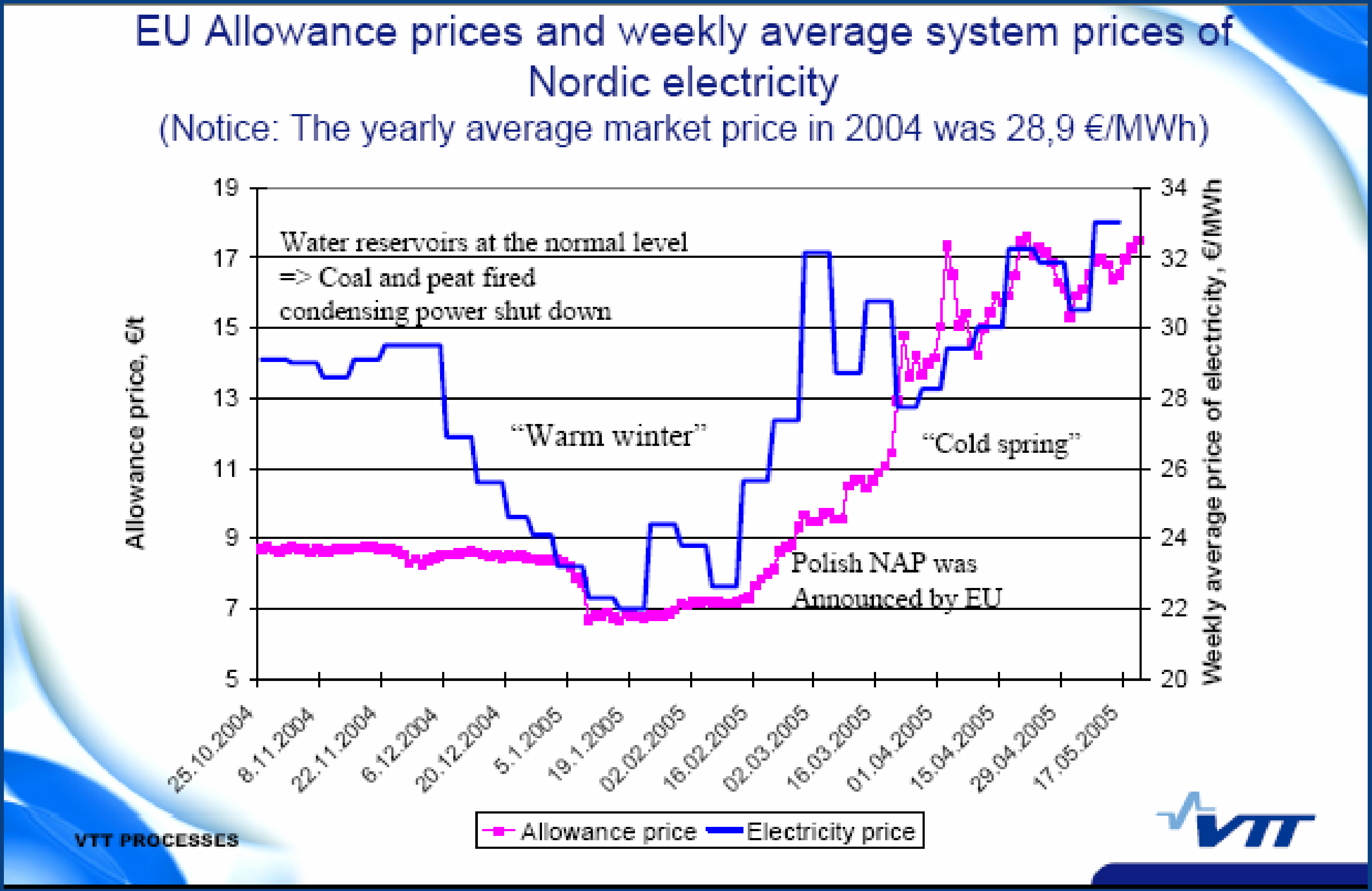
Allowance value is expected to be passed through to customers even if allowances are received for free



Source: VTT Processes of Finland.

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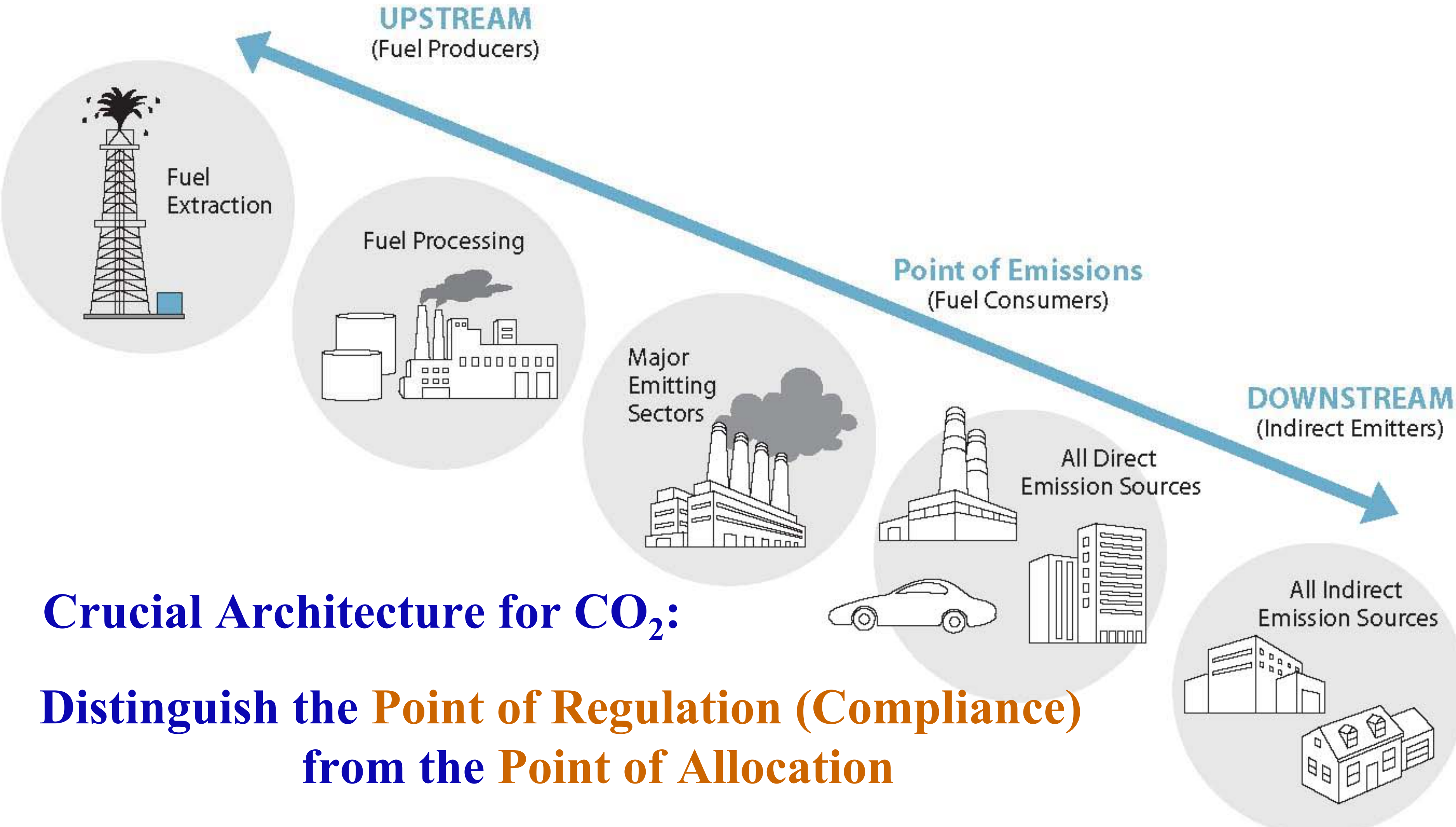
Point of Regulation Does Not Mean Point of Allocation



Crucial Architecture for CO_2:

Distinguish the Point of Regulation (Compliance) from the Point of Allocation

Principle Should Guide Allocation (1)

- Emission allowances represent enormous value and present strong incentives for rent seeking.
- Experience with Title IV – notional adherence to a simple rule lessened rent seeking and contributed to success of program.
- Principle rather than contest of self-interest should guide climate policy.

Principle Should Guide Allocation (2)

Efficiency is one such bedrock principle.

- Overwhelming evidence is that free distribution has hidden cost.
  - Auction preferred when prices of goods and services differ from opportunity costs in:
    - Factor markets (e.g. taxes) (Goulder, Parry, others)
    - Product market (e.g. electricity regulation)(Burtraw and Palmer, Parry)
    - The allocation approach can amplify or diminish the distortion away from economic efficiency.
  - Rent seeking is another source of transaction cost.
- Most expansive environmental policy ever faced; free distribution would multiply the cost dramatically.
- Absent a public policy rationale, there is an economic case against free distribution of any emission allowances.

What is academic advice on the distribution of emission allowances?

- Economics literature broadly finds there are significant efficiency advantages to auctioning emission allowances.

Why give any allowances away for free?

1. Compensation
   - But 100% free allocation to generators can dramatically over-compensate affected firms at expense of consumers raising concerns about equity.
   - Free allocation to regulated load serving entities provides compensation to customers, at some efficiency loss.
2. Promote Technology
3. Promote Competition

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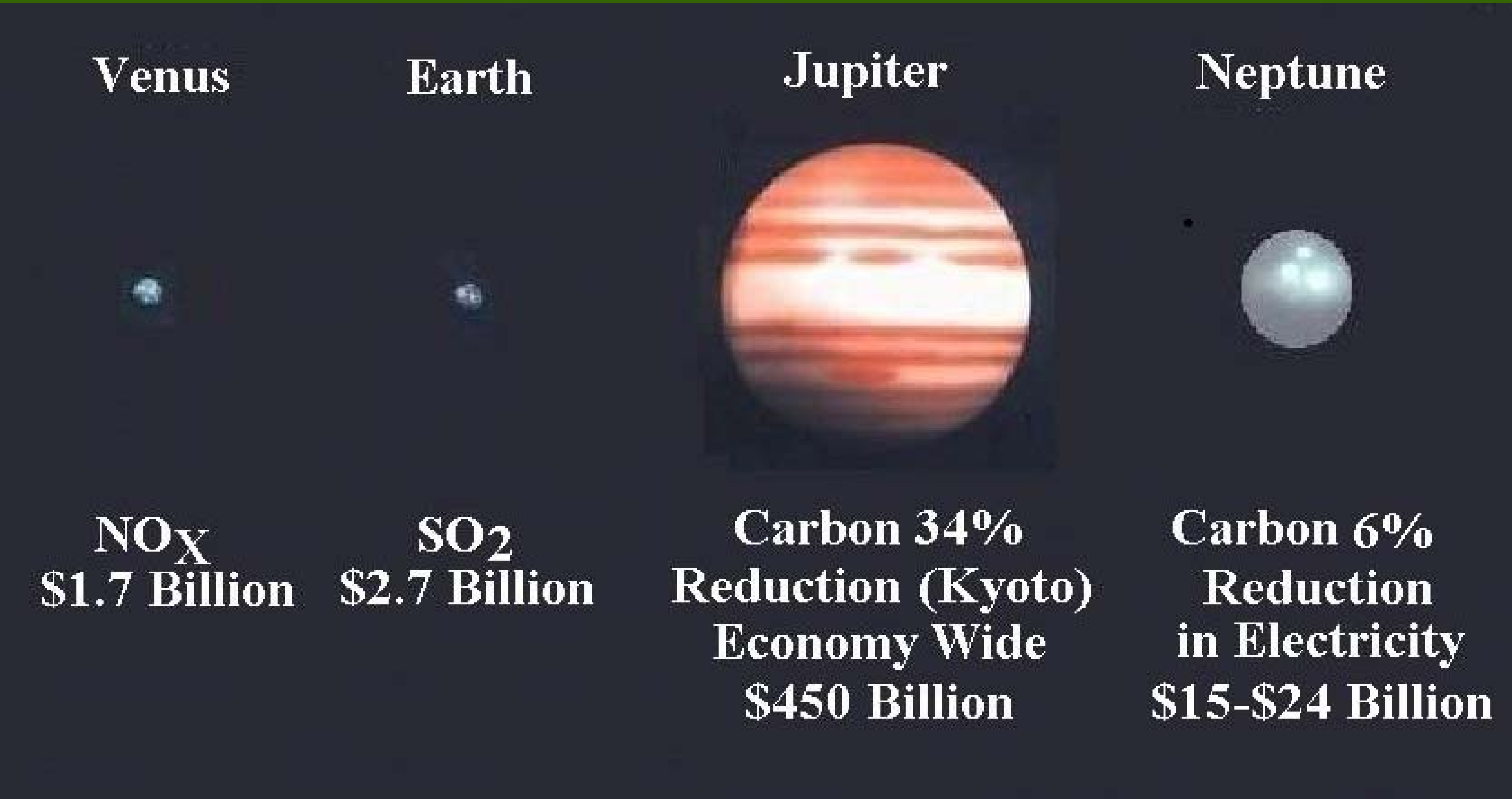
The Asset Value is Unprecedented

Annual Asset Value of Emission Allowances



V.a. Regional Greenhouse Gas Initiative (RGGI) Model Rule

Seven northeast states plus Maryland.
Status of Massachusetts and Rhode Island is uncertain.

- Program to start in 2009. Applies to all generating units over 25 MW that sell to grid.
- Stabilize emissions at current levels through 2014. Review in 2015.
- Ramp down to 10% below current levels by 2019.
- State apportionment based on emissions and other factors.
- States responsible for allocation to sources. Encouraged to dedicate **20%** for public benefits purpose and **5%** for strategic purposes.
- Banking and early reduction credits allowed.

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Initial Distribution of Allowances in RGGI

- **Apportionment to States:**

  Establish emission budgets for each state

- **Allocation:**

  States distribute emission allowances

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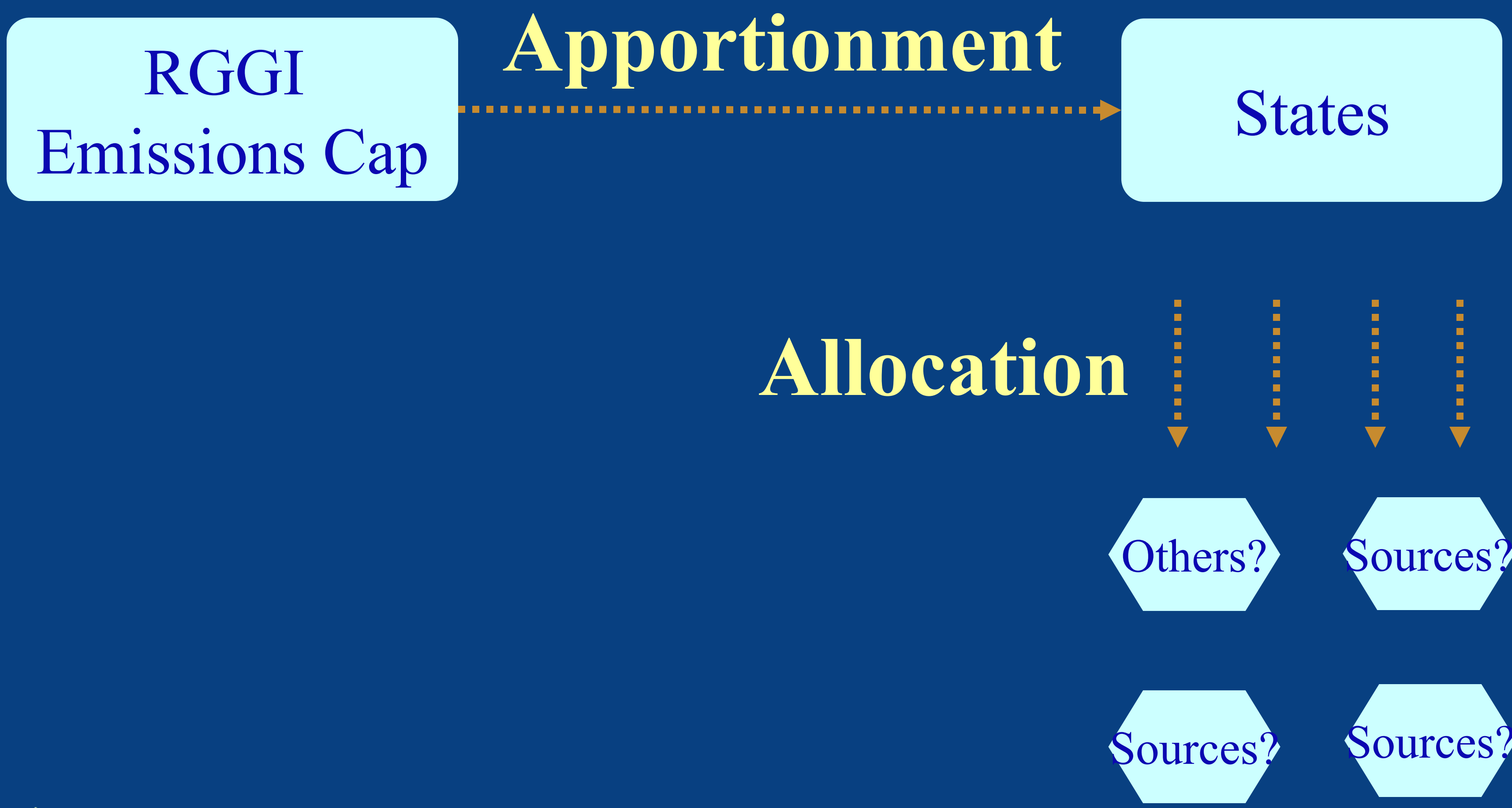
Initial Distribution of Allowances



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Summary of the RGGI Staff Working Group Proposal

- **Apportionment to States:**

  Based on historic emissions, but also considers electricity consumption, population, expected new sources and other factors

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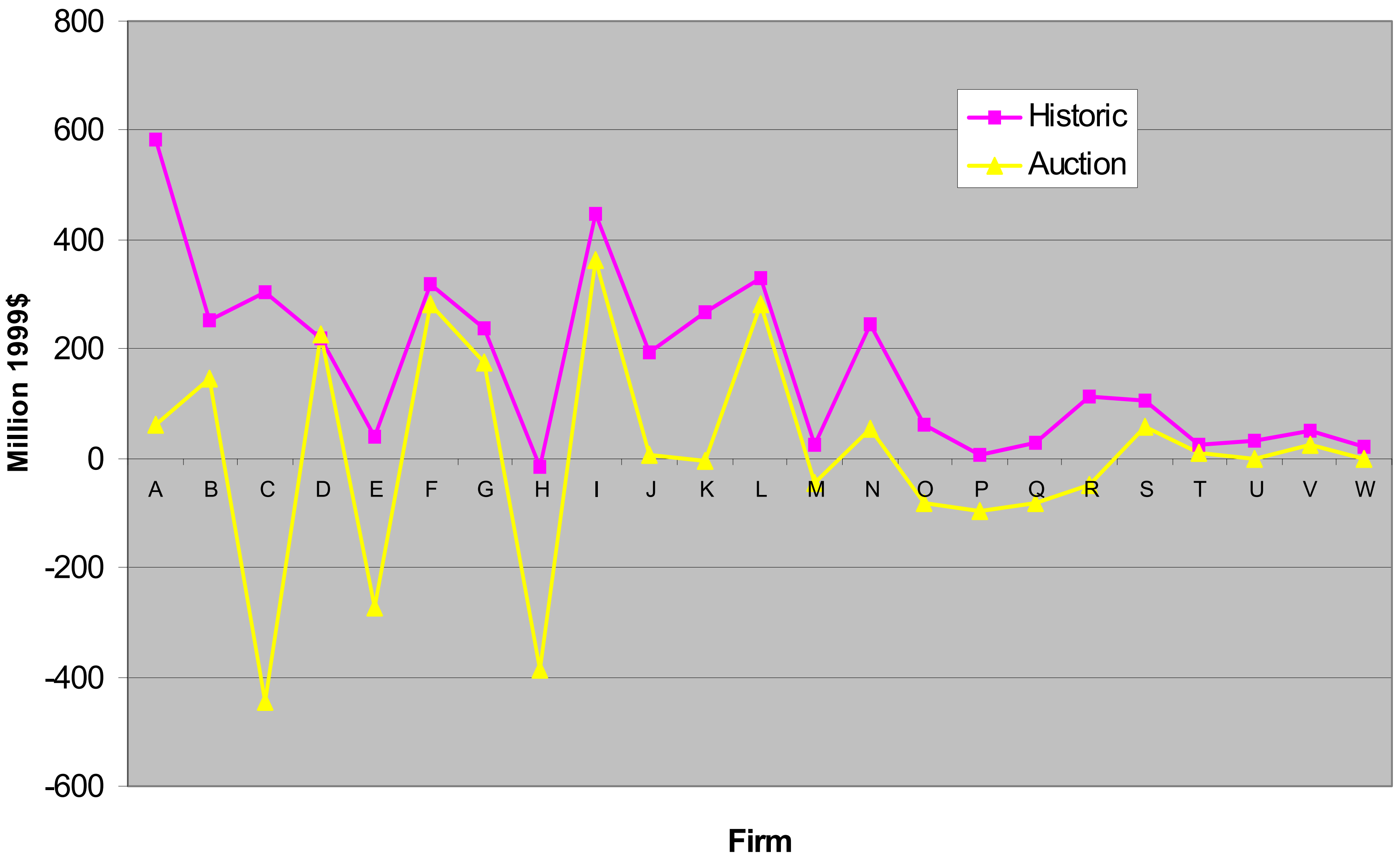
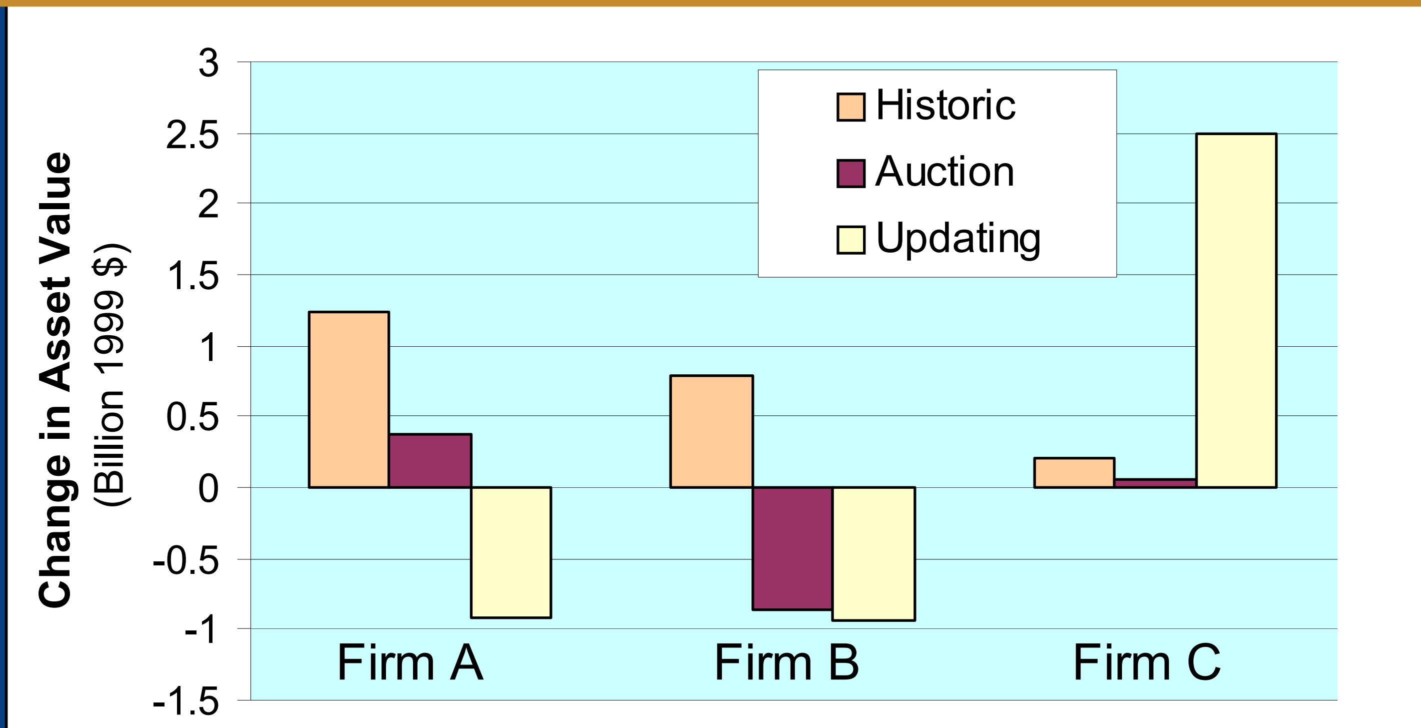
Summary of the RGGI Staff Working Group Proposal (2)

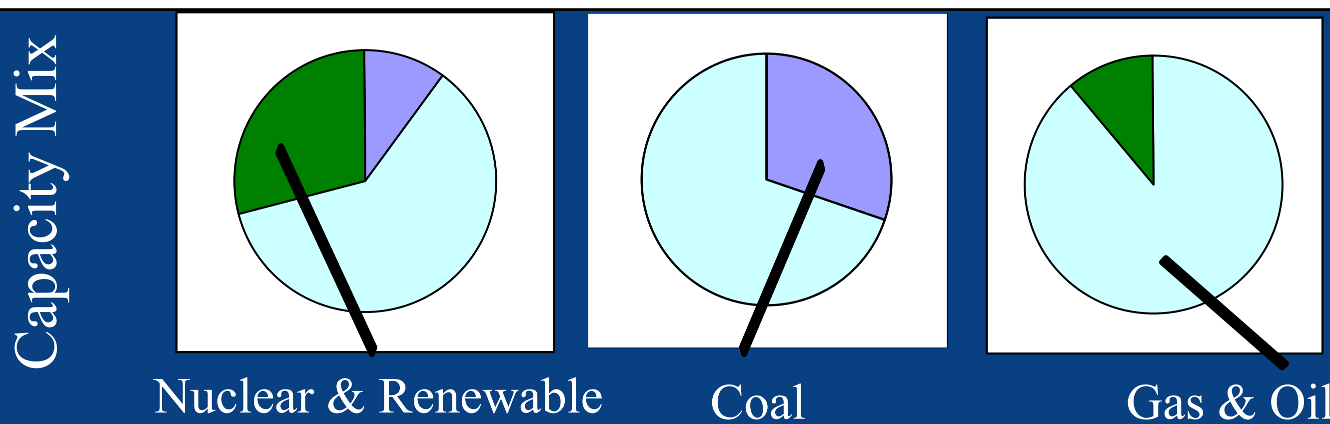
- **Allocation to Firms and Others**
  - Generally, decisions left to States (similar to EU ETS or the US NO_x Budget Trading Program)
  - However,
    - States must propose that 20% of allowances be used for a "public benefits" purpose
    - States set aside 5% for a Strategic Carbon Fund to achieve additional emissions reduction outside the cap
    - **In sum, at least 25% of allowance value distributed through auction or alternative**

Change in Value for 23 Largest Firms in Northeast Under RGGI

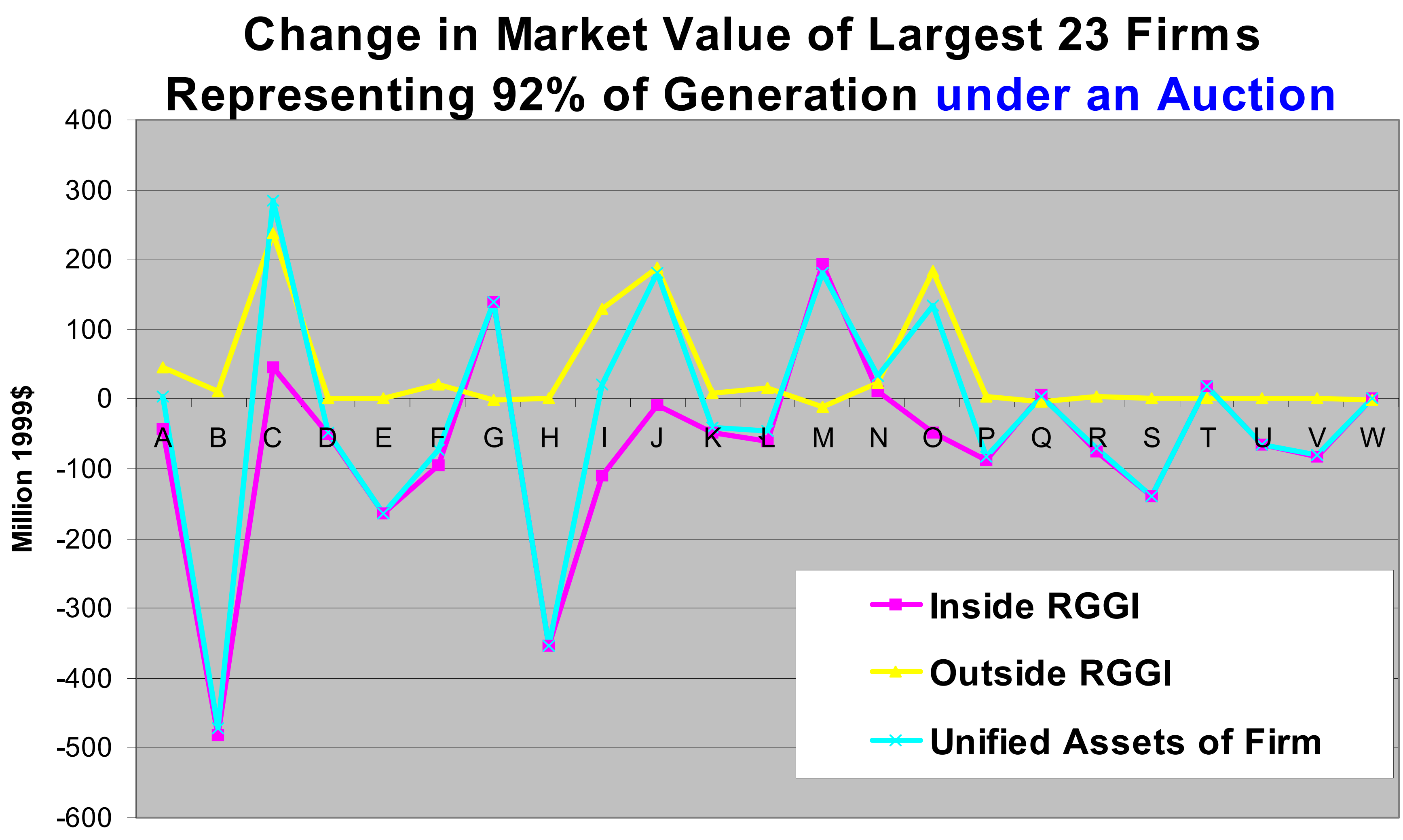


How well firms do inside the RGGI region depends on their portfolio of assets

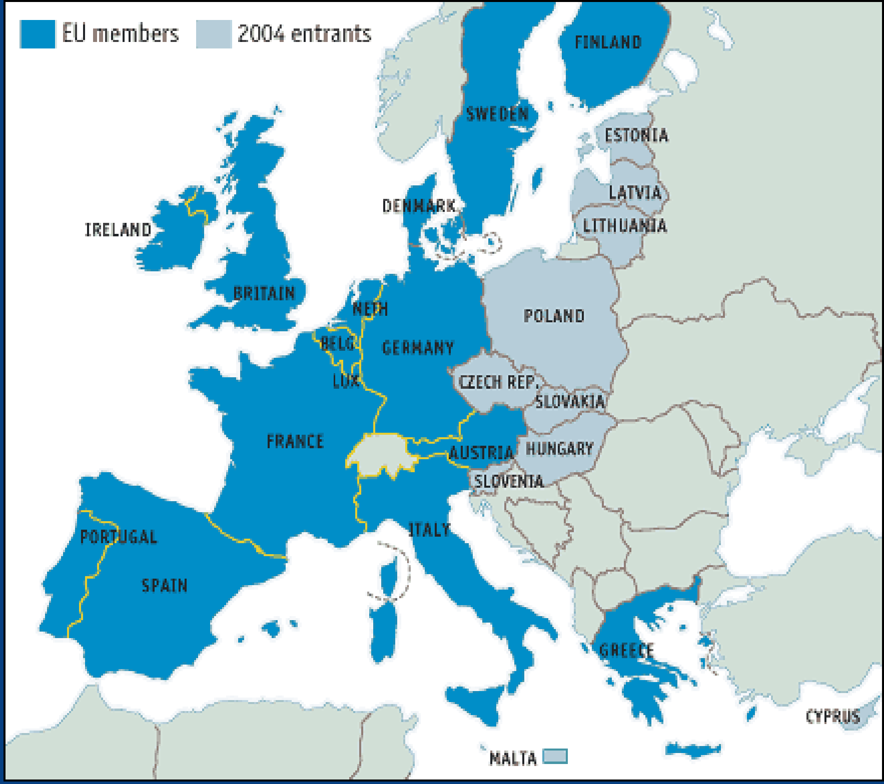




How well firms do also depends on assets outside the RGGI region



V.b.Summary of the EU Trading System



- **Participants:**
  25 Member States (MS)
- **Timing:** Periods are 2005-2007 and 2008-2012
- **Coverage:**
  - **Sectors:** Energy activities (including electric power), iron & steel, minerals, pulp and paper
  - ~12,000 installations covering 46% of CO_2 emissions

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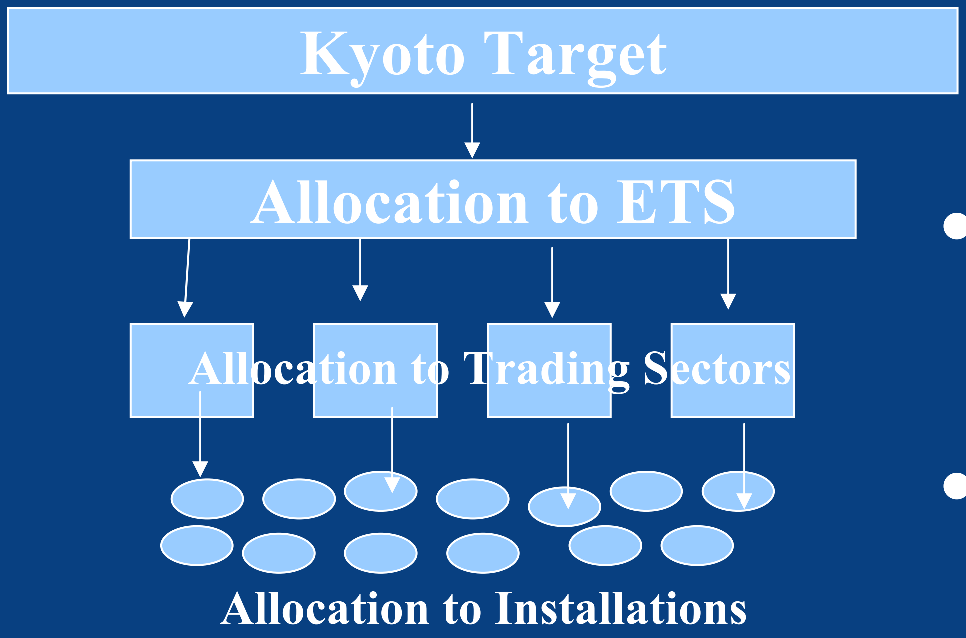
National Allocation Plans: Multiple Decisions



- Decision #1: How much of Kyoto target will be in trading program?
- Decision #2: What will be the allocations for each sector?
- Decision #3: How will allowances be allocated to each installation?

National Allocation Plans (NAPs) Criteria for EU ETS

- Consistent with overall Kyoto target
  - Take into account
    - Proportion of emissions in capped sector
    - Other policies
    - Technical potential of activities within sector
    - Early action
    - Competition from non-EU countries
    - New entrants
- Allowances \$20 – \$40 billion annual value!
- May auction 5% in Phase I, 10% in Phase II (maximum)

Distributional Issues

- Data from German, Nordic and other power markets show grandfathered allowances passed on in price of power
- Recent UK study: power sector received about $1 billion windfall
- Adjustments of phase II NAPS?

Comparison of RGGI and EU

- Both programs largely follow the SO_2/NO_x downstream model, but add some new twists
- Transport sector not covered
- Allocation processes are decentralized to meet political considerations of multiple jurisdictions

V. c.Winners & Losers in Potential US Policy NCEP/Bingaman Proposal

NATIONAL COMMISSION ON ENERGY POLICY

- Economy wide cap on CO_2 emissions based on 2.4-2.8% decline in CO_2 intensity per year.
- $7 (nominal) cap on CO_2 allowance price in 2010 increasing at 5% per year till 2025
- Full trading and banking of CO_2 allowances
- Small portion of allowances to be auctioned.
- NCEP proposal includes much more than CO_2 cap and trade.

Winners and Losers

NATIONAL COMMISSION ON ENERGY POLICY

- **Consumers** realize greatest loss, but harm is diffuse.
- Measure of "deserved" compensation for **generators** depends on the yard-stick.
  - Industry-level cost is 1/8th of allowance value in competitive regions (1/16th nationally). But this assumes winners compensate losers.
  - At firm-level, a perfectly precise policy could achieve *full compensation* for **22%** of allowance value, creating $8 billion for winners.

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NPV of CO_2 Emission Allowances = $141 billion

Allocation Review

- Compliance responsibility and allocation should be thought of as separate questions
- In RGGI as in the EU ETS, the allocation process is decentralized to meet the political considerations of multiple jurisdictions
- The emission allowance trading program creates many winners as well as losers
- One can expect the initial distribution of allowances to have a large effect on efficiency and distribution of costs

VI. Basic Architecture

Principles:

1. The fundamental divide: voluntary or binding
2. More important to start early than to start large
3. More important to end economy-wide than to start there
4. Compensation through allocation
5. Efficiency is essential as constraints tighten

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Conclusion

- Climate is long run problem. Design of institution matters tremendously. Efficiency plays an increasingly important role as policies expand.

- In the important electricity sector, role of regulation is crucial to prices, incentives, efficiency and fairness.

Thank You

Guidance for California

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The California Climate Change Center
http://calclimate.berkeley.edu

Project Directors:
W. Michael Hanemann
Alexander E. Farrell

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1. Introduction
2. Economic Assessments
3. Technological Innovation
4. Technologies for Managing GHGs
5. **Lessons for a Cap-And-Trade Program**
6. End-Use Energy Efficiency
7. Modeling Endogenous Technological Change
8. Transportation
9. Modeling the California Electricity Sector
10. Synthesis

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